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NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

Press Kit

SPACE SHUTTLE

For Release IMMEDIATE

Project SPACE SHUTTLE ORBITER TEST FLIGHT SERIES

RELEASE NO: 77-16

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(NASA-News-Release-77-16) SPACE SHUTTLE ORBITER TEST FLIGHT SERIES (National Aeronautics and Space Administration) 61 p
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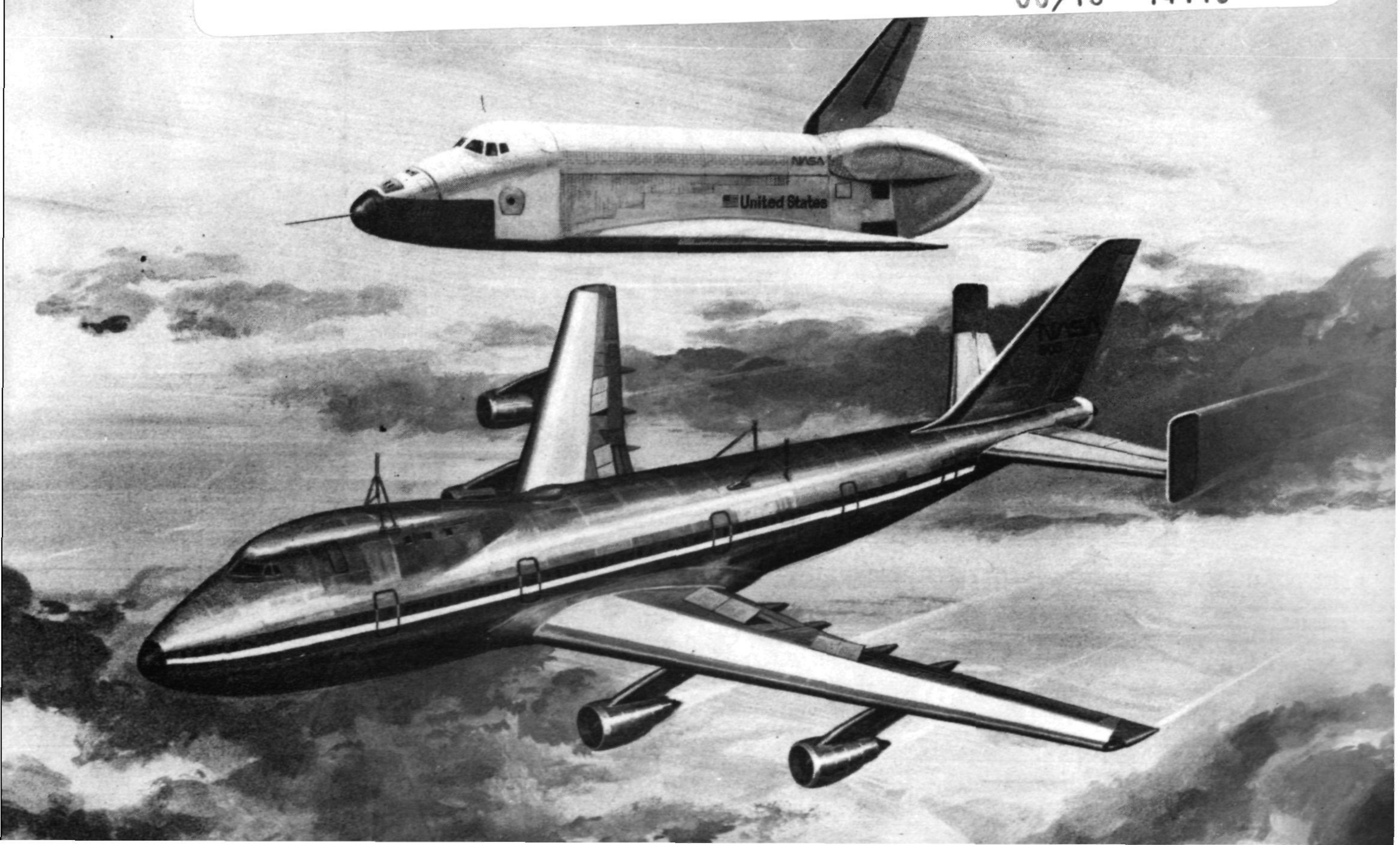

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For Release:

IMMEDIATE

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RELEASE NO: 77-16

SPACE SHUTTLE ORBITER TEST FLIGHT SERIES TO BEGIN

The Space Shuttle orbiter will fly this year following a series of test taxi runs and captive flight tests while still attached to its carrier airplane. In February, a year-long series of low altitude flights to verify the aerodynamic and flight control characteristics of the first Shuttle Orbiter will take place at NASA's Dryden Flight Research Center, Edwards, Calif.

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Mailed:
February 4, 1977

These Orbiter test flights, the Approach and Landing Tests (ALT), are under the management of NASA's Johnson Space Center, Houston, Tex., and are being conducted at Dryden Center and the Air Force Flight Test Center (AFFTC) located at Edwards Air Force Base, Calif. This test site has several distinct advantages including a 4,570-meter (15,000-foot) long by 90-m (300-ft.) wide paved runway, in addition to lakebed runways which are extremely long and wide.

ALT is a series of flights with a modified Boeing 747 Shuttle Carrier Aircraft (SCA) serving as a ferry aircraft and airborne launch platform for the 67,500-kilogram (75-ton) Orbiter, named the Enterprise. The tests begin with several taxi tests of the SCA, with the Orbiter atop, followed closely by a series of six inert captive flights with the jumbo jet carrying the unmanned Orbiter to altitudes of 7,620 m (25,000 ft.).

The unmanned Orbiter captive flights are to verify performance of the two vehicles in mated flight. They will be followed by five captive active flights in which the Orbiter systems will be powered up and the Enterprise will be manned by two NASA astronauts.

These active flights are designed to verify crew procedures and systems operations. Actual release of the Orbiter from the SCA first occurs in a subsequent series of flights.

Up to eight free flights are scheduled with the SCA serving as the airborne platform from which the Orbiter will be launched. These flights, with NASA astronauts at the controls of the unpowered Orbiter, are designed to verify the Orbiter's subsonic airworthiness, integrated systems operations and pilot-guided and automatic approach and landing capabilities.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used a minimum of 100 times. It is as big as a commercial jetliner (DC-9); its empty weight is 68,000 kg (150,000 lb.); it is 37.2 m (122 ft.) in length and it has a wingspan of 23.8 m (78 ft.). The Orbiter is to be launched into low Earth orbit early in 1979, with its three main engines being augmented by a pair of solid rocket boosters.

The Space Shuttle is composed of the Orbiter, the two solid rocket boosters and an external fuel tank which feeds the Orbiter's three engines.

The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid boosters will be recovered, refurbished and reused. The external tank will be jettisoned, but not recovered.

Enterprise, the first Orbiter (101) be used in the Dryden flight test program, is the first development article of the Shuttle program to come off the assembly line. Under construction since June 19, 1974, the Enterprise's main parts come from numerous aerospace contractors throughout the country. The crew module and aft fuselage were fabricated by the prime contractor, Rockwell International's Space Division, Downey, Calif.; the mid-fuselage (cargo bay) by General Dynamics, San Diego, Calif.; wings by the Grumman Aerospace Corp. of Bethpage, N.Y.; and its tail assembly by the Fairchild Republic Co., Farmingdale, N.Y.

The Orbiter's three main engines, each of which provide 2.1 million newtons (470,000 lb.) of thrust at launch, are being built by the Rocketdyne Division, Rockwell International, Canoga Park, Calif.

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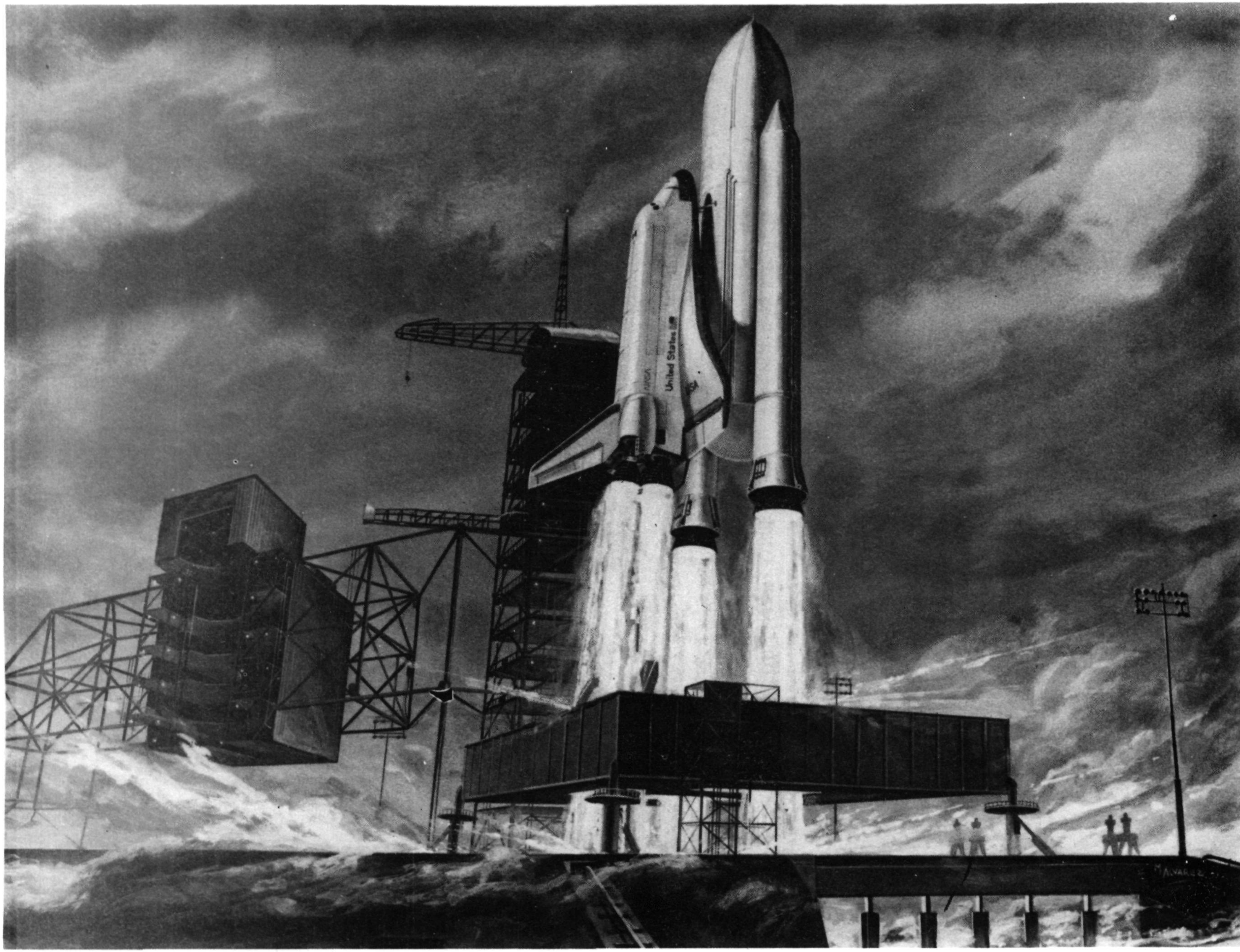
Enterprise was transferred from the Rockwell International assembly plant at Palmdale, Calif., to the Dryden Center Jan. 31. At completion of ALT, this first Orbiter will be ferried atop the SCA to NASA's Marshall Space Flight Center, Huntsville, Ala., where it will undergo extensive ground vibration tests. Subsequent to these tests it will return to the Rockwell facility at Palmdale and prepare for orbital flight sometime in the early 1980s.

The second Orbiter (102), currently under construction, will be the first vehicle to be used in the Shuttle Orbital Flight Test (OFT) program which is scheduled to begin in mid-1979. Six OFT flights are planned to demonstrate the Orbiter's capabilities in Earth orbit before the start of the Shuttle operational flights which are scheduled to begin in 1980.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)


United States


United States

SPACE TRANSPORTATION SYSTEM

The Space Transportation System of the next decade will consist of the Space Shuttle, Spacelab and upper stages to propel payloads beyond the capability of the Shuttle to synchronous orbit and to the planets.

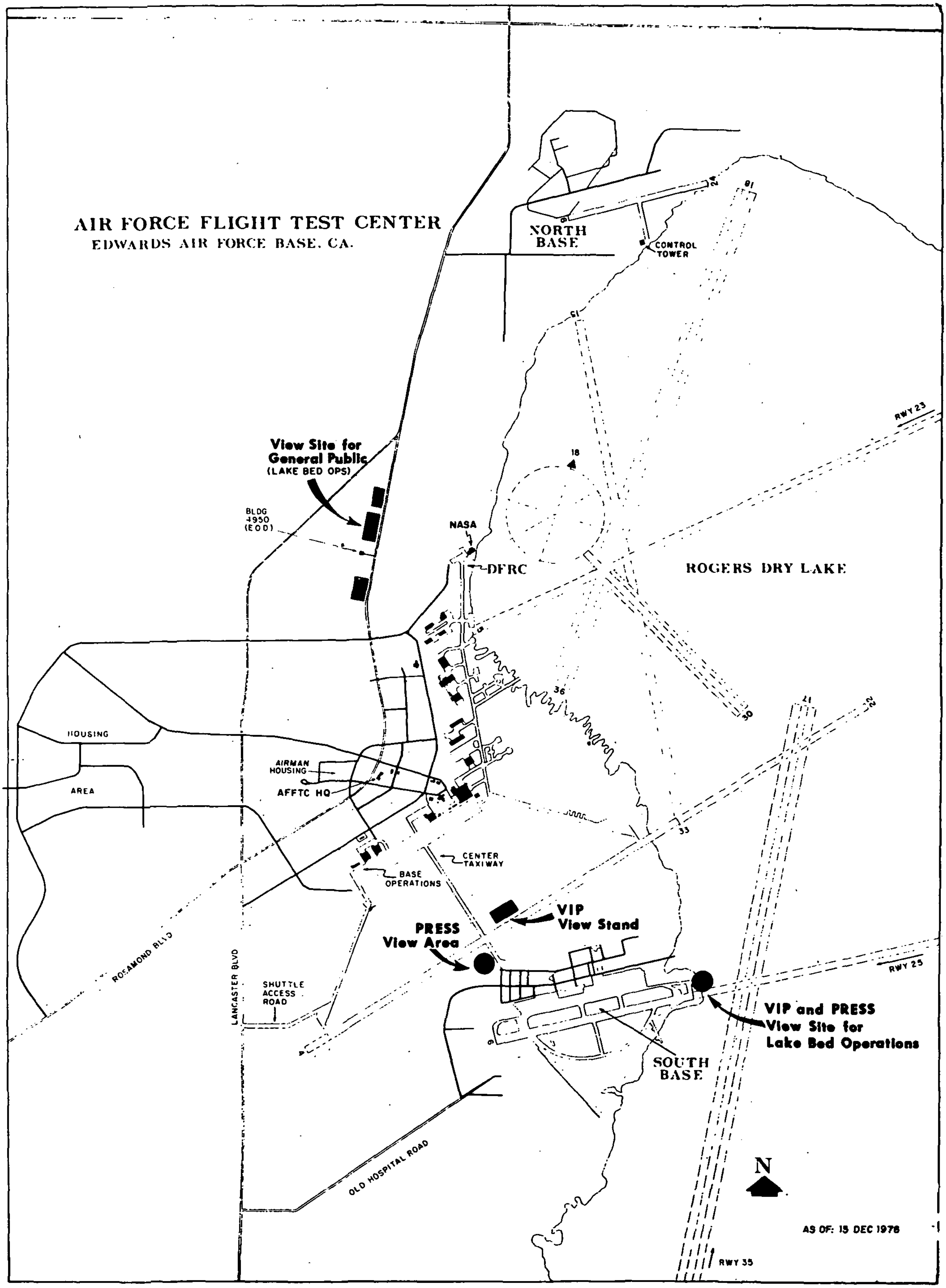
With the Space Shuttle, the rather large stable of launch vehicles that we use today -- both civilian and military -- will be greatly reduced. The Shuttle will be used to place almost all our satellites into orbit and, more importantly, it will have the capability to retrieve malfunctioning satellites and repair them in orbit or return them to Earth. This capability assumes particular importance with the predicted growing future requirements for additional weather, Earth resources, communication and navigational satellites. No longer will it be necessary to write off a multi-million-dollar satellite due to a malfunction following launch.

The Space Shuttle will be capabable of carrying the Spacelab into orbit. Spacelab, carried in the Shuttle cargo bay, provides a shirtsleeve, pressurized environment for scientific and technical investigators to work in space. Airlocks and a pallet external to the pressurized area will be available for experiments that require direct access to the space environment.

For lunar and planetary missions, the Shuttle will be capable of carrying upper stages into Earth orbit which will propel probes and satellites into outer space. These upper stages will also be used to place satellites into high geosynchronous orbits.

APPROACH AND LANDING TESTS

The Orbiter Approach and Landing Tests program is to verify subsonic airworthiness, pilot-guided and automatic landing capabilities of the Orbiter. These tests, which will be conducted at NASA's Dryden Flight Research Center, Edwards Air Force Base, Calif., will begin in February 1977, with a series of unmanned and manned flights mated on top of a modified 747 jetliner, the Shuttle Carrier Aircraft (SCA). (See ALT schedule.)


AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CA.
NORTH BASE
CONTROL TOWER
View Site for General Public (LAKE BED OPS)
BLDG 4950 (EOD)
NASA
DFRC
ROGERS DRY LAKE
RWY 23
HOUSING
AREA
AIRMAN HOUSING
AFFTC HQ
CENTER TAXIWAY
BASE OPERATIONS
VIP View Stand
PRESS View Area
ROSAMOND BLVD
LANCASTER BLVD
SHUTTLE ACCESS ROAD
RWY 25
VIP and PRESS View Site for Lake Bed Operations
SOUTH BASE
OLD HOSPITAL ROAD
N
AS OF: 15 DEC 1978
RWY 35

The first tests call for the 101 vehicle to be placed on top of the SCA for a number of taxi runs on the runway at Edwards. The taxi tests will be followed by six captive flights where the unmanned Orbiter will be carried to an altitude of approximately 7,600 m (25,000 ft.) by the SCA, but not released.

These unmanned captive flights will be followed by a series of captive flights with the ALT crew aboard the Orbiter. These tests are designed to verify most of the Orbiter's systems and crew procedures as well as provide some verification of Orbiter dynamics and controllability.

A series of manned free flights will be conducted beginning in July 1977. The Orbiter will be carried aloft, released from the 747 carrier and flown to an unpowered landing four to five minutes later on a dry lake bed landing strip at Edwards. The SCA, specifically modified for these test flights, will carry the Orbiter to an altitude of about 8,500 m (28,000 ft.). All dates, flight profiles, flight times and procedures are subject to change as the program progresses.

<u>Taxi Test</u>

The taxi tests will be conducted on Runway 04-22 at Edwards AFB. All taxi tests will be scheduled early in the morning to minimize problems associated with heat build-up in the tires and brake system.

The first run of the mated configuration (Orbiter/Shuttle Carrier Aircraft) starts at the end of the runway with the vehicle traveling southwest to northeast. The test will be terminated when the airplane reaches a speed of 75 knots. After an inspection of the tires and brakes, the second test will begin with the airplane traveling up to a speed of 120 knots, when normal braking will be applied.

The final run will be performed at a maximum speed of 135 knots. Thrust reversers, in addition to normal braking and speed brakes, will be applied.

<u>Captive Inert Flights</u>

Six flights with an unmanned inert Orbiter are planned. These tests are concerned with verifying performance, stability and control, flutter margin and buffet characteristics of the mated configuration in flight patterns similar to the manned Orbiter free flights and to insure safe operation of the combined vehicle configuration.

-more-

The combined weight of the two vehicles, dependent upon flight requirements, will vary from about 265,350 kg (585,000 lb.) to about 285,770 kg (630,000 lb.). The inert Orbiter will weigh 68,000 kg (150,000 lb.).

Flights and primary objectives are as follows:

Flight 1 - Obtain evaluation of low speed performance and handling qualities.

Flight 2 - Interim evaluation of stability and control characteristics and completion of airspeed systems calibration.

Flight 3 - Complete basic flutter and stability testing, and explore minimum flying speed for heavy and light gross weight conditions at several 747 flap settings.

Flight 4 - Investigation of marginal operational characteristics and simulated engine-out conditions.

Flight 5 and 6 - These two flights will be similar, for the most part, with primary purpose of evaluating the performance and procedures associated with the launch attempt of the Orbiter from the 747. Maximum altitude and speed will be 7,620 m (25,000 ft.), and 509 km/hr (275 knots).

Captive Active Orbiter (Manned Testing)

Astronaut crews will be aboard the Orbiter during the six active captive flights which are designed to determine the optimum separation profile based on inert test results, refine and finalize Orbiter and SCA crew procedures and evaluate Orbiter integrated systems operations. Five of the flights will be with the Orbiter tailcone attached and the sixth with the tailcone off. The tailcone is an aerodynamic fairing to reduce buffeting on the 747 tail surfaces. Its use permits higher altitudes. It will be used on all 747-Orbiter ferry flights.

The captive active flights and their primary objectives are:

Flight 1 - The first manned Orbiter mated test will go to an altitude of 7,225 m (23,700 ft.) and fly three times around the "racetrack" course (approximately 67 by 24 km (40 by 14 mi.). The Orbiter crew will perform normal operational checks and systems operations. During this flight, low speed 435 km/hr (235 kts) and high speed 480 km/hr (260 kts) flutter checks will be performed to evaluate Orbiter structural dynamic response characteristics. On the inbound leg of the third circuit around the racetrack, a pushover and separation trajectory will be flown at 480 km/hr (260 kts) to collect separation performance data.

Flight 2 - This flight is dedicated to the verification of the separation conditions and tolerances, as well as checks of the Orbiter's avionics systems and further procedures development. As in the first flight, the 747 will fly three times around the racetrack trajectory. On the inbound leg of the second circuit around the racetrack, a pushover and separation trajectory will be flown at 500 km/hr (270 kts) to collect separation performance data. During final descent, the SCA/Orbiter mated configuration will fly through the autoland trajectory.

Flights 3-5 - The third, fourth and fifth flights are dedicated to further refinement and demonstration of separation procedures (short of actual release), separation abort techniques, chase aircraft operations and performances of avionics tests.

After the fifth manned captive flight with the tailcone on, the first of five free flights with tailcone on are planned. These will be followed by the sixth manned captive flight with the tailcone off.

Flight 6 - Purpose of this flight is to demonstrate the separation performance and flight worthiness of the Orbiter and 747 in a tailcone off configuration. Orbiter and 747 crews will go through the preseparation procedures as will be performed in the free flight , short of separation.

Based on the 747 buffeting experience with the tailcone off on flight 6, a decision will be made whether to proceed with the sixth, seventh and eighth free flights with tailcone off.

Free Flights - ALT

A series of up to eight free flights are scheduled to follow the manned captive flights at Dryden Center. The free flights are designed to verify Orbiter subsonic airworthiness, integrated system operations and pilot-guided approach and landing capability and satisfying prerequisites to automatic flight control and navigation mode. The first five free flights will be flown with tailcone on.

The tailcone on flights will generally follow this pattern:

The flight path of the Orbiter and 747 follows a race-track pattern with separation occurring when the vehicles are about 13 km (8 mi.) to the right and flying parallel to the landing runway. From the separation point, the Orbiter will fly a U-shaped ground track to the runway.

To perform the separation maneuver, the 747 will pitch down to -6 degrees and accelerate to establish equilibrium glide conditions of 270 knots equivalent air speed (KEAS) and -9.2 degrees flight path angle. At this point, the Orbiter pilot will initiate separation by arming and firing a series of explosive bolts at an altitude of about 6,700 m (22,000 ft.) above runway level.

At separation, the Orbiter pilot will command a pitch up maneuver which will provide a vertical separation of more than 60 m (200 ft.) in about five seconds. The 747 will turn left while the Orbiter turns right to provide horizontal separation. The Orbiter crew will then perform a series of test maneuvers to obtain data on the Orbiter aerodynamics, flight control and systems operation. On the first flight the Orbiter will pitch down, accelerate to 270 KEAS and then perform a practice landing (at 18,000 ft. altitude), allowing the airspeed to decrease to 185 KEAS while evaluating the flying qualities of the Orbiter.

The Orbiter pilot will then pitch down to accelerate and, at the same time, initiate the first of two 90-degree turns to the left which will align it with a lakebed runway.

At the completion of the second turn, the Orbiter is aligned with the runway at an altitude of 1,980 m (6,500 ft.) and about 14 km (9 mi.) from the touchdown point, speed 270 KEAS, flight path -9 degrees.

First flare (preflare) starts at an altitude of 270 m (900 ft.), and transfers to the Orbiter from the -9 degree glide slope to a -1.5 degree glide slope. The landing gear is deployed shortly afterward, at about 105 m (350 ft.) altitude and the landing flare (final flare) is initiated at slightly less than 30 m (100 ft.) altitude. The final flare establishes a sink rate of approximately 3 feet per second which is held to touchdown. Touchdown airspeed is about 180 KEAS and elapsed time from separation to touchdown is about 5 minutes, 15 seconds.

Because of the increased drag when the streamlined Orbiter tailcone is removed, the maximum altitude the 747 can achieve and the distance the Orbiter can glide after release, are reduced. Thus, for tailcone off flights, the Orbiter will be launched at an altitude of 5,400 to 5,600 m (17,700 to 18,300 ft.) above runway level and 19.3 km (12 mi.) from the end of the runway. Launch and separation procedures will be the same as for the tailcone on flights, but the Orbiter will fly a "straight in" approach to the runway instead of the U-shaped ground track flown with tailcone on.

Approach speed will be 290 KEAS, flight path -24 degrees and preflare will start at an altitude of 600 m (2,000 ft.). Landing gear deployment, final flare and landing will be similar to tailcone on flights. Flight time from release to landing will be two and a half minutes or less.

FREE FLIGHT PLAN

Flight	Configuration	Description	Major Objectives
1	Tailcone on	Practice flare at altitude 180 degree turn Lake bed landing	Manual landing Handling qualities Gentle braking Nose wheel steering
2	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 45-degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed and with speed brake Turn maneuverability Nose wheel steering
3	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 35-degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed and with speed brake Turn maneuverability Nose wheel steering
4	Tailcone on	FCS* mode switching Manual direct FCS 180-degree turn Auto FCS Closed loop auto guidance to above preflare altitude Lake bed landing	Verify FCS modes and switching Auto guidance Steering with differential braking
5	Tailcone on	180-degree side approach to concrete landing 45 degree speed brake	Concrete landing Braking on paved surface Autoland information

Before commitment to the sixth free flight, a high-speed tailcone-off taxi test will be performed. If this is satisfactory, the sixth captive manned tailcone off flight will be performed. Based on the buffeting experienced, a decision will be made to proceed with the sixth, seventh and eighth free flights with tailcone off.

* FCS - Flight Control Subsystem

Flight	Configuration	Description	Major Objectives
6	Tailcone off	Practice flare at altitude	Manual landing Handling qualities
7	Tailcone off	Auto FCS 45-degree speed brake Closed loop auto guidance to above preflare altitude Speed brake retraction Lake bed landing	Auto guidance Speed brake modulation
8	Tailcone off	Closed loop auto guidance and speed brake modulation to touchdown Lake bed landing	Auto guidance Auto landing

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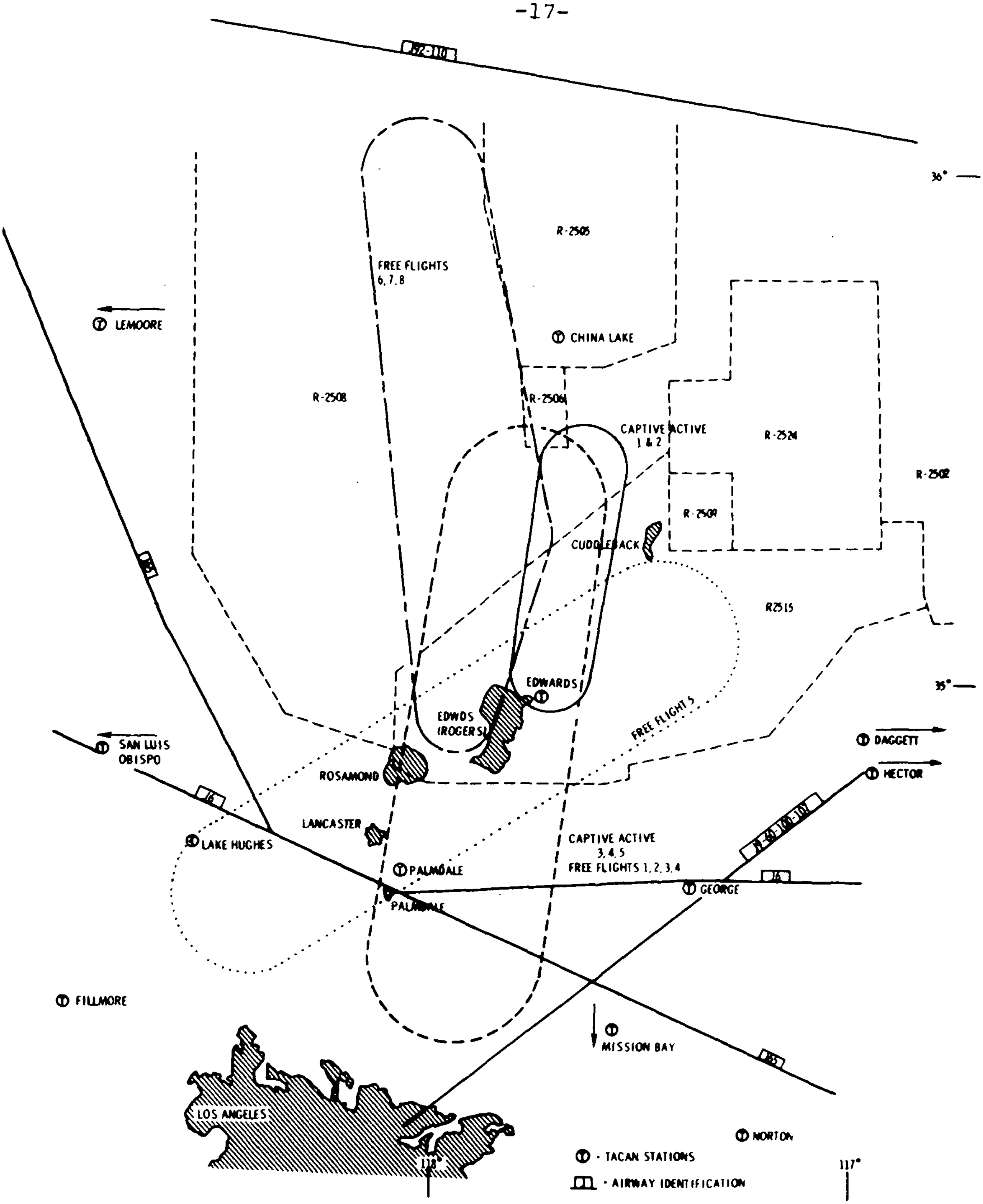
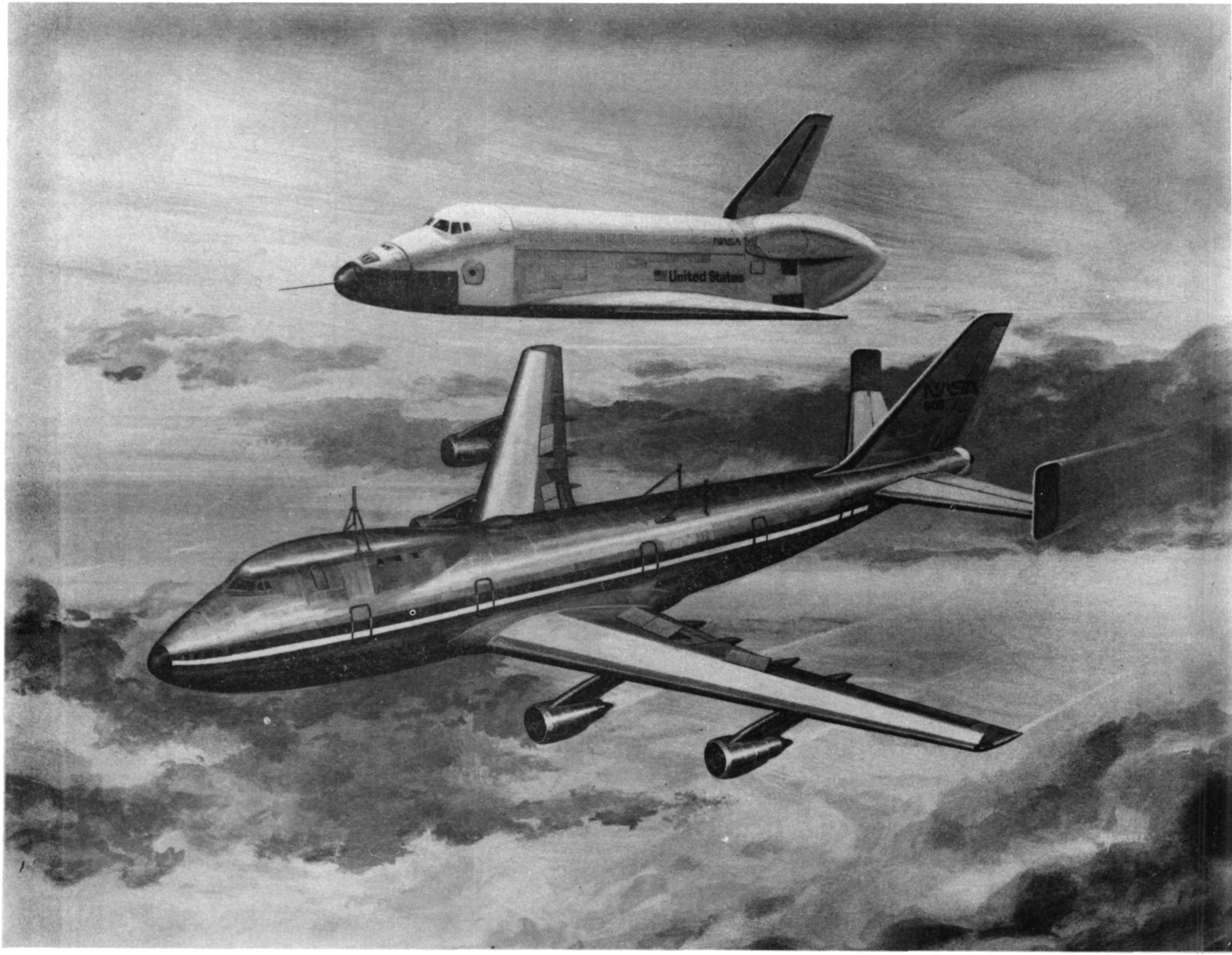

R-2505
FREE FLIGHTS
6, 7, 8
LEMOORE
CHINA LAKE
R-2508
R-2506
CAPTIVE ACTIVE
1 & 2
R-2524
R-2502
R-2509
CUDDLEBACK
R2515
EDWARDS
EDWDS
(ROGERS)
FREE FLIGHT 5
SAN LUIS
OBISPO
DAGGETT
HECTOR
ROSAMOND
LANCASTER
LAKE HUGHES
CAPTIVE ACTIVE
3, 4, 5
FREE FLIGHTS 1, 2, 3, 4
PALMDALE
GEORGE
PALMDALE
FILLMORE
MISSION BAY
LOS ANGELES
NORTON
TACAN STATIONS
AIRWAY IDENTIFICATION
36°
35°
118°
117°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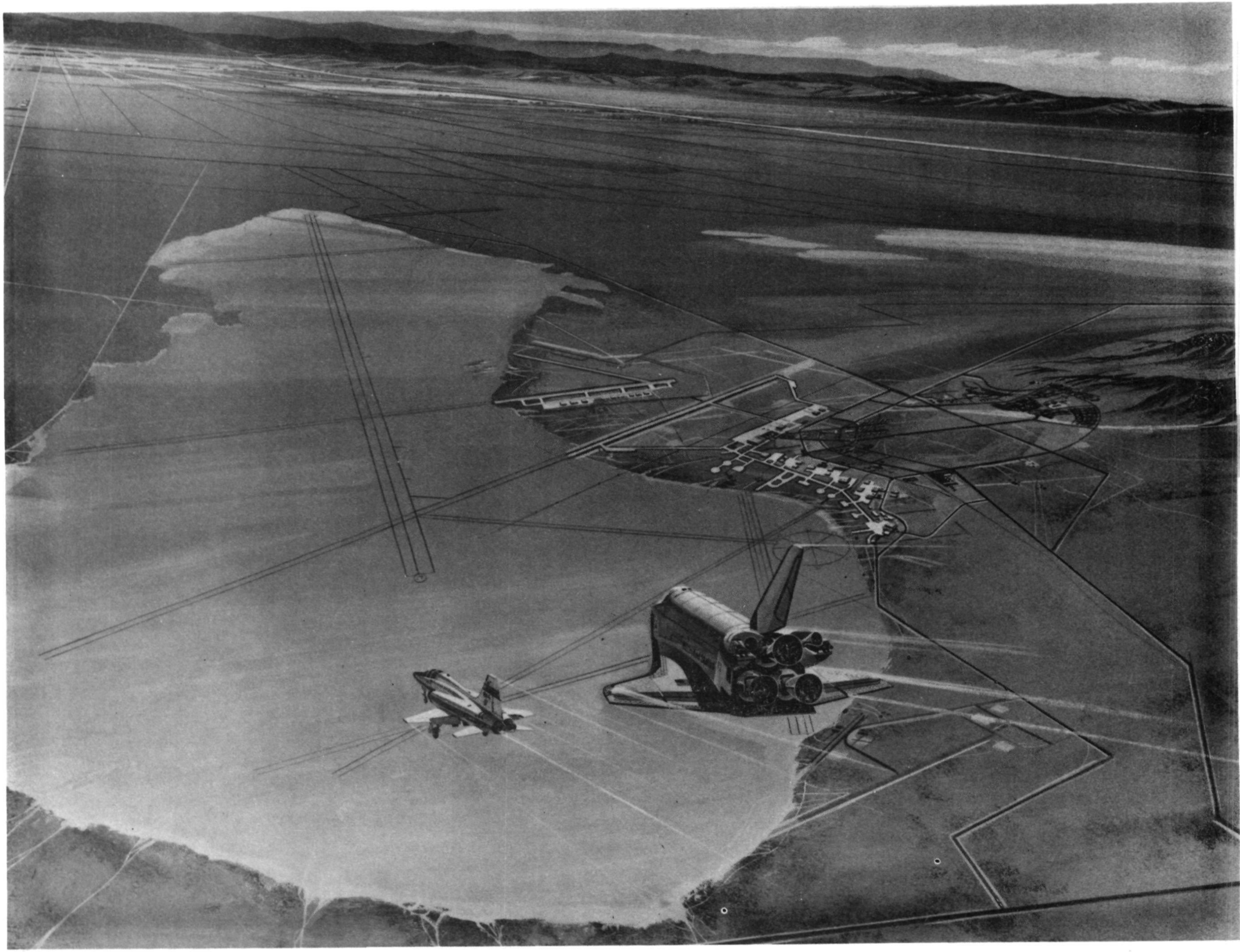

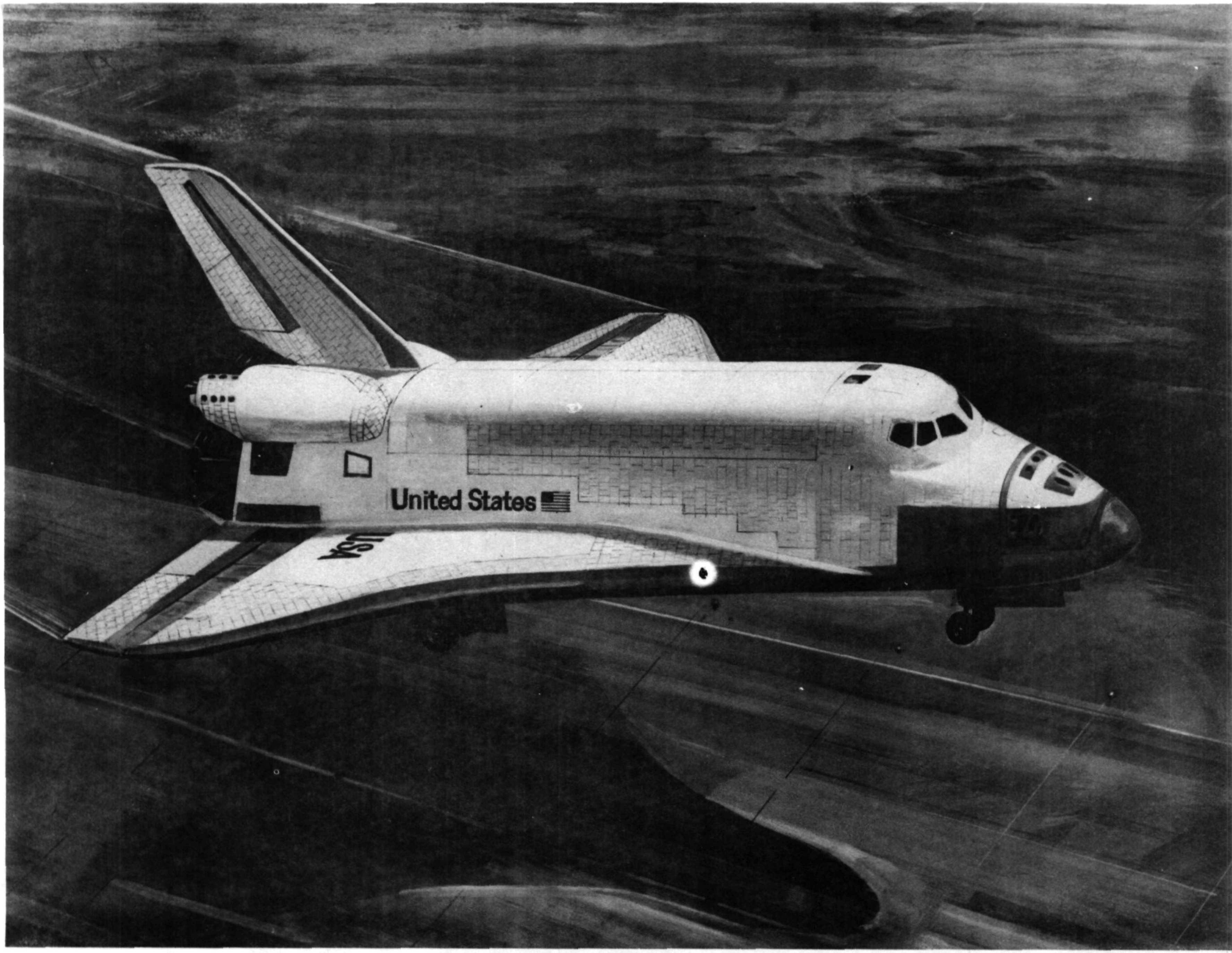
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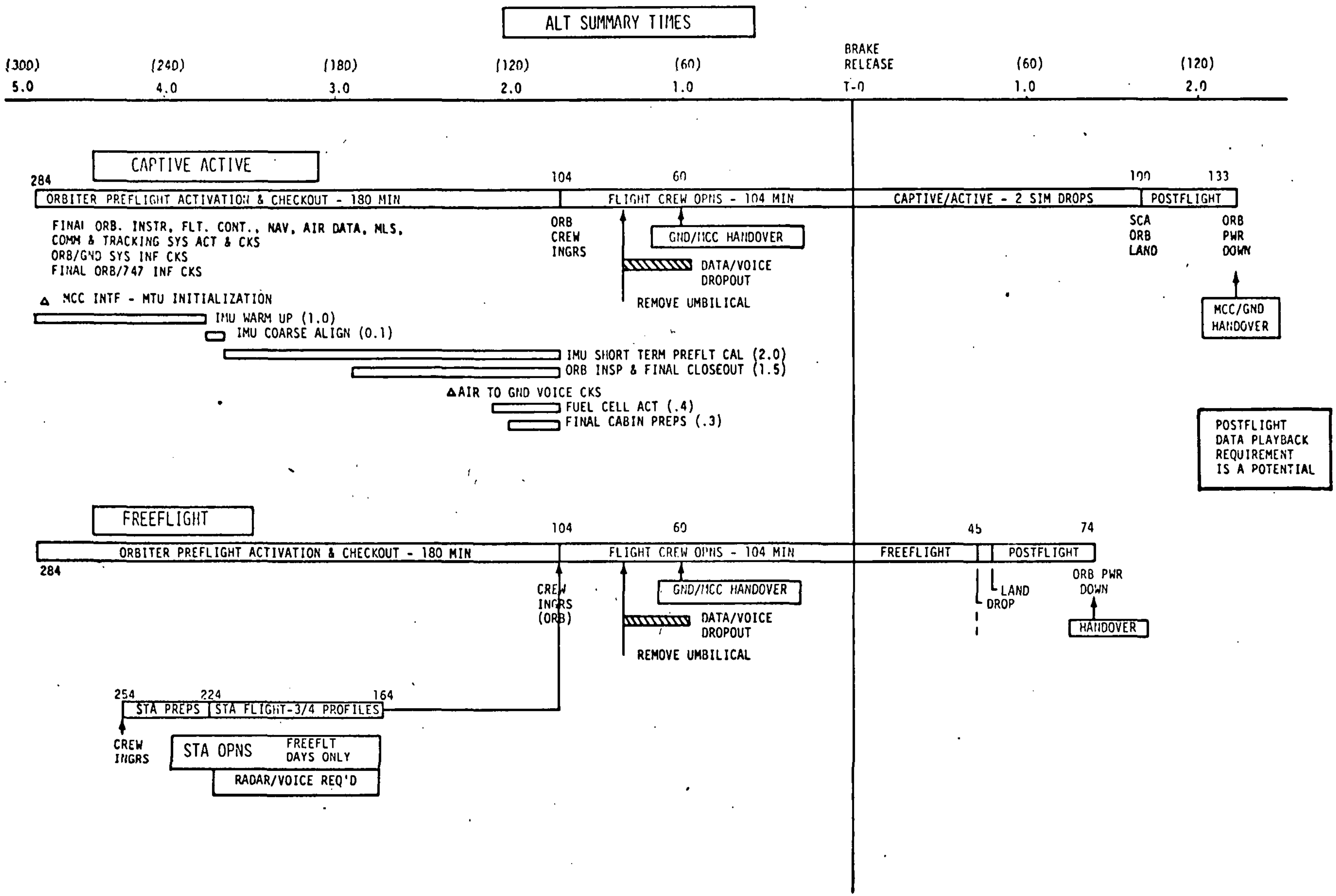
USA

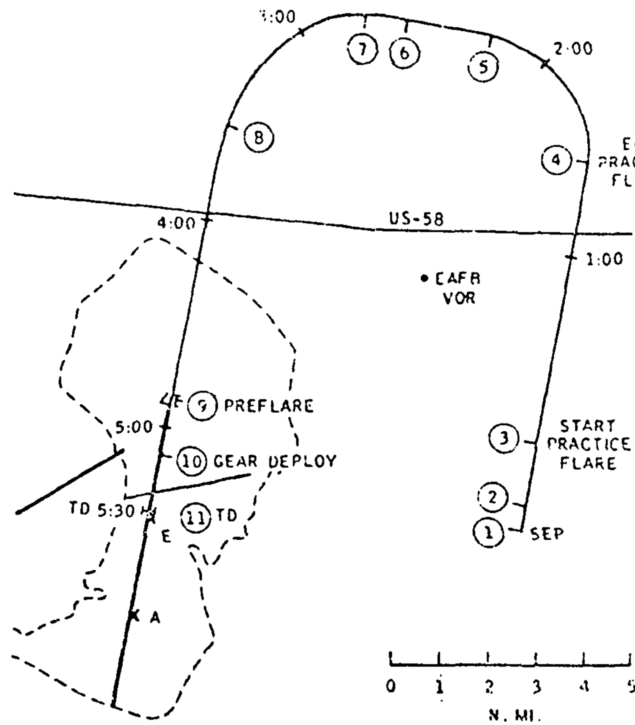


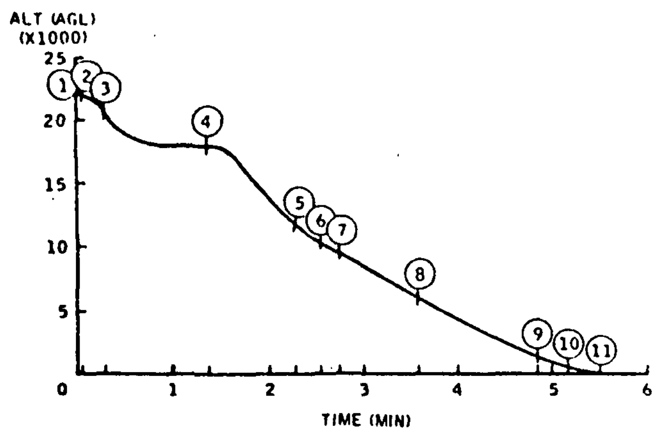
ALT SUMMARY TIMES
(300) 5.0
(240) 4.0
(180) 3.0
(120) 2.0
(60) 1.0
BRAKE RELEASE T-0
(60) 1.0
(120) 2.0
CAPTIVE ACTIVE
284
104
60
100
133
ORBITER PREFLIGHT ACTIVATION & CHECKOUT - 180 MIN
FLIGHT CREW OPNS - 104 MIN
CAPTIVE/ACTIVE - 2 SIM DROPS
POSTFLIGHT
FINAL ORB. INSTR, FLT. CONT., NAV, AIR DATA, MLS,
COMM & TRACKING SYS ACT & CKS
ORB/GND SYS INF CKS
FINAL ORB/747 INF CKS
ORB CREW INGRS
GND/MCC HANDOVER
DATA/VOICE DROPOUT
REMOVE UMBILICAL
SCA ORB LAND
ORB PWR DOWN
MCC/GND HANDOVER
MCC INTF - MTU INITIALIZATION
IMU WARM UP (1.0)
IMU COARSE ALIGN (0.1)
IMU SHORT TERM PREFLT CAL (2.0)
ORB INSP & FINAL CLOSEOUT (1.5)
AIR TO GND VOICE CKS
FUEL CELL ACT (.4)
FINAL CABIN PREPS (.3)
POSTFLIGHT DATA PLAYBACK REQUIREMENT IS A POTENTIAL
FREEFLIGHT
104
60
45
74
ORBITER PREFLIGHT ACTIVATION & CHECKOUT - 180 MIN
284
FLIGHT CREW OPNS - 104 MIN
FREEFLIGHT
POSTFLIGHT
CREW INGRS (ORB)
GND/MCC HANDOVER
DATA/VOICE DROPOUT
REMOVE UMBILICAL
DROP
LAND
ORB PWR DOWN
HANDOVER
254
224
164
STA PREPS
STA FLIGHT-3/4 PROFILES
CREW INGRS
STA OPNS
FREEFLT DAYS ONLY
RADAR/VOICE REQ'D

SECTION 5.6

ALT FREE FLIGHT 1

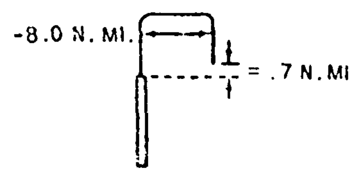
ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10
3	0:18	20400	270	6	-10	AT AS = 270 INITIATE PRACTICE FLARE $\dot{\theta}$ = 2°/SEC; CONTINUE FLARE TO HOLD $\dot{h}$ = 0, AS = 185
4	1:25	17900	185	11	11	AT AS = 185 $\dot{\theta}$ = -1°/SEC TO θ = -6°; ROLL LEFT TO ϕ = 30°
5	2:15	12000	240	8	-6	AT ψ = 265° ROLL TO ϕ = 0
6	2:35	10000	265	6	-6	AT AS = 265 $\dot{\theta}$ = 1°/SEC TO θ = -2 TO HOLD AS = 270
7	2:45	9300	270	5	-2	ROLL LEFT TO ϕ = 30° TO LINE UP ON RUNWAY ψ = 175°
8	3:35	6000	270	5	-2	TURN COMPLETE HOLD AS = 270
9	4:55	900	270	5	-2	INITIATE PREFLARE
10	5:10	350	250	6	4	AT AS = 250, DEPLOY GEAR
11	5:30	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
12	5:45	0	100	--	--	AT AS = 100, GENTLE BRAKING TO AS = 80
13	6:00	0	50	--	--	AT AS = 50, ENGAGE NWS





WT = 150,000

CG = 64.5 % (1070.24)



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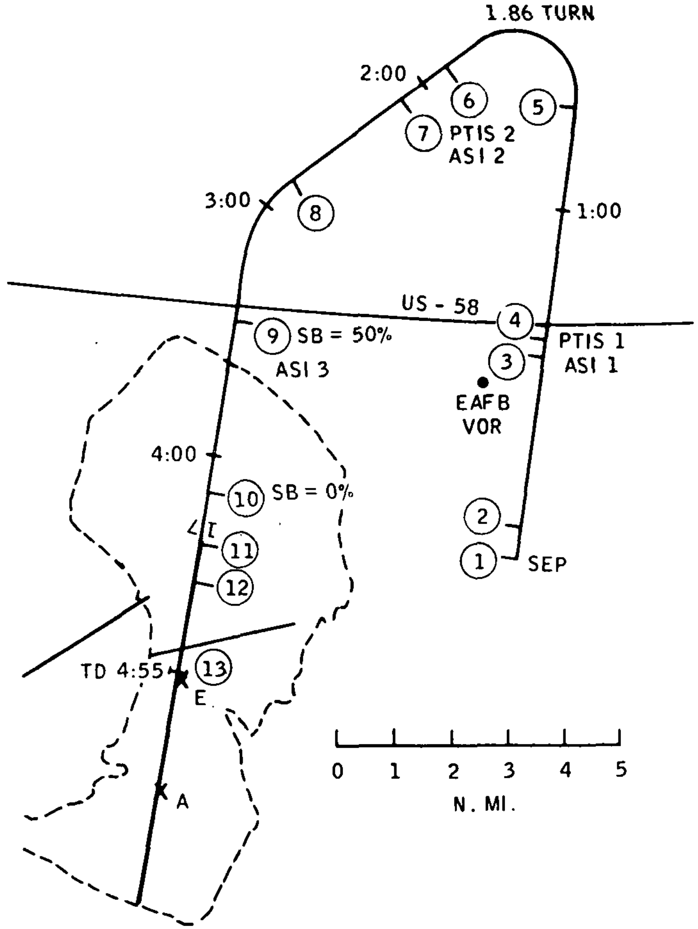
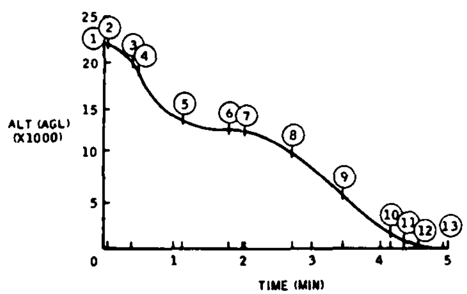
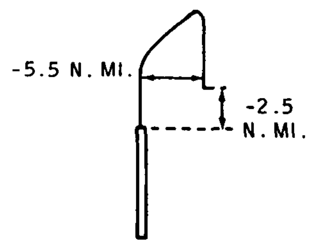
ALT FREE FLIGHT 2

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10
3	0:33	18200	295	5	-10	$\dot{\theta}$ = 2°/SEC TO θ = -3° TO HOLD AS = 300
4	0:35	17600	300	5	-3	PTIS; STICK INPUTS (TOTAL 35 SEC)
5	1:10	13600	300	5	-3	$\dot{\theta}$ = 1°/SEC TO θ = 3; ROLL LEFT 55°; HOLD N_z = 1.8g (α < 13°) TURN TO ψ = 220°
6	1:50	12400	230	9	10	ϕ = 0; $\dot{\theta}$ = -1°/SEC TO θ = 2 HOLD AS = 200
7	2:05	12200	200	9	2	PTIS; STICK INPUTS (35 SEC)
8	2:40	10300	200	9	2	ROLL LEFT ϕ = 30°; $\dot{\theta}$ = -1°/SEC TO θ = -9° TURN TO ψ 175°
9	3:28	5500	260	5	-9	$\dot{\theta}$ = 1°/SEC TO θ = -7°; SB = 50% HOLD AS = 270; STICK INPUTS (15 SEC)
10	4:08	2000	270	5	-7	SB → 0
11	4:20	900	270	5	-7	INITIATE PREFLARE
12	4:35	350	250	6	4	AT AS = 250, DEPLOY GEAR
13	4:55	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
14	5:10	0	90	--	--	AT AS = 90, ENGAGE NWS
15	5:25	0	60	--	--	LOW TO MODERATE BRAKING AS REQUIRED WHEN AS < 60





WT = 150,000
CG = 64.4% (1070.24)



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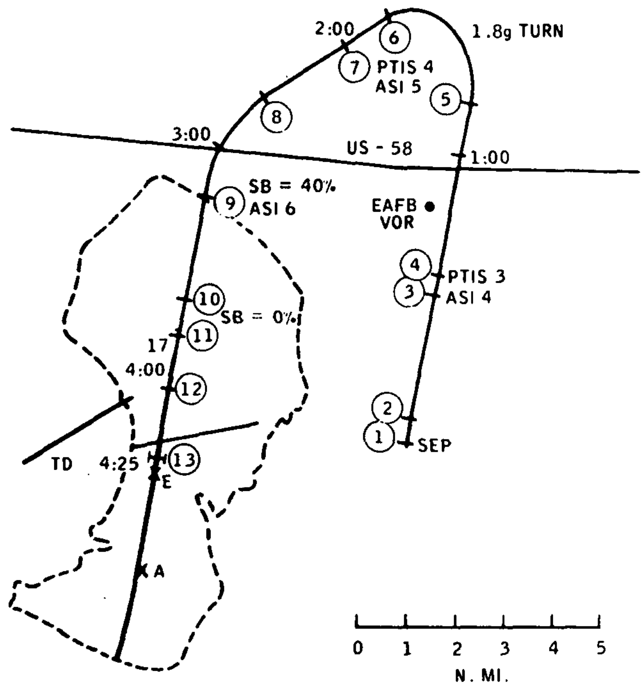
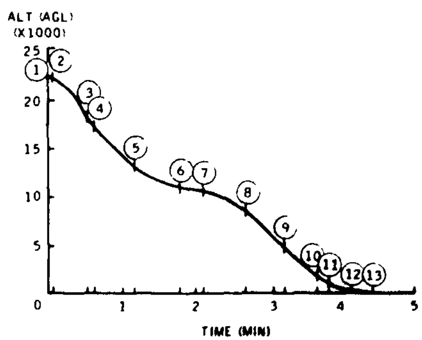
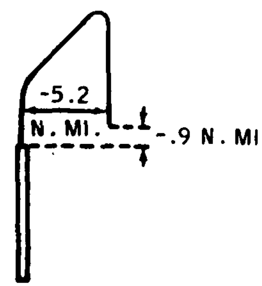
ALT FREE FLIGHT 3

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10°; BF = 0
3	0:33	17700	295	5	-10	$\dot{\theta}$ = 2° SEC TO θ = -5 TO HOLD AS = 300
4	0:35	17000	300	5	-5	PTIS; STICK INPUTS (TOTAL 35 SEC)
5	1:10	13100	300	5	-5	$\dot{\theta}$ = 1°/SEC TO θ = 3; ROLL LEFT 55°; HOLD N_z = 1.8g (α < 13°) TURN TO ψ = 220°
6	1:50	10900	230	9	10	ϕ = 0; $\dot{\theta}$ = -1°/SEC TO θ = 2 HOLD AS = 200
7	2:05	10700	200	9	2	PTIS; STICK INPUTS (35 SEC)
8	2:40	8500	200	9	2	ROLL LEFT ϕ = 30°; $\dot{\theta}$ = -1°/SEC TO θ = -9° TURN TO ψ = 175°
9	3:14	4600	260	5	-9	$\dot{\theta}$ = 1°/SEC TO θ = -7°; SB = 40% HOLD AS = 270; STICK INPUTS (15 SEC)
10	3:38	2000	270	5	-7	SB → 0; BF → -11.7
11	3:50	900	270	5	-7	INITIATE PREFLARE
12	4:05	350	250	6	4	AT AS = 250, DEPLOY GEAR
13	4:25	0	175	11	11	T. D. AS < 229; $\dot{h}$ < 10 fps
14	4:35	0	115	--	--	AT AS = 115 ENGAGE NWS
15	4:55					MODERATE TO HARD BREAKING AS REQUIRED WHEN AS < 60





WT = 150,000
CG = 66.5% (1096.05)



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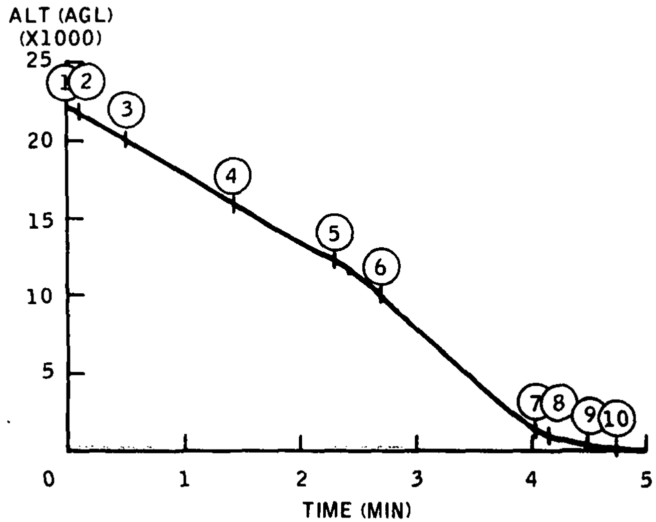
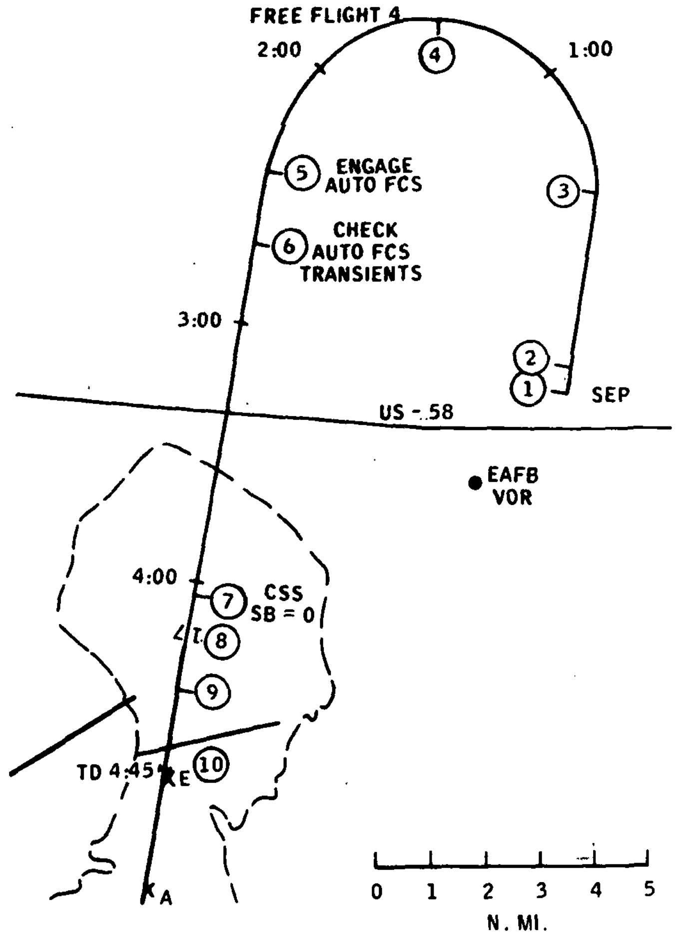
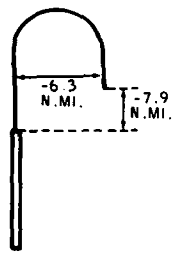
ALT FREE FLIGHT 4

ITEM	TIME	ALT (AGL)	KEAS	α	Θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\Theta}$ = 2°/SEC, 3 SEC; $\dot{\Theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\Theta}$ = -1°/SEC TO Θ = 0°, ROLL ϕ = 0.
3	0:30	20100	250	7	0	ROLL LEFT ϕ = 30°; HOLD AS = 250
4	1:25	16000	250	7	0	STEER VEHICLE TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDE-SLOPE (Θ = -5) WHEN ψ < 225° FLY GUIDANCE ERROR NEEDLES AND SPEEDBRAKE COMMANDS
5	2:20	12100	250	7	-5	WHEN THE GUIDANCE NEEDLES ARE CENTERED ENGAGE AUTO FCS AND SB
6	2:42	10000	270	6	-5	MONITOR AUTO GUIDANCE AND DISENGAGE AND ENGAGE
7	3:58	2000	270	6	-5	FCS → CSS; SB → 0
8	4:10	900	270	6	-5	INITIATE PREFLARE
9	4:25	350	250	6	5	AT AS = 250, DEPLOY GEAR
10	4:45	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
11	5:20	0	50	--	--	AT AS < 50, MAKE 6° HEADING CHANGES WITH DIFFERENTIAL BRAKING





WT = 150,000
CG = 64.5 % (1070.24)
BF = -11.7 ENTIRE FLIGHT
AUTO GUIDANCE GS = -12°



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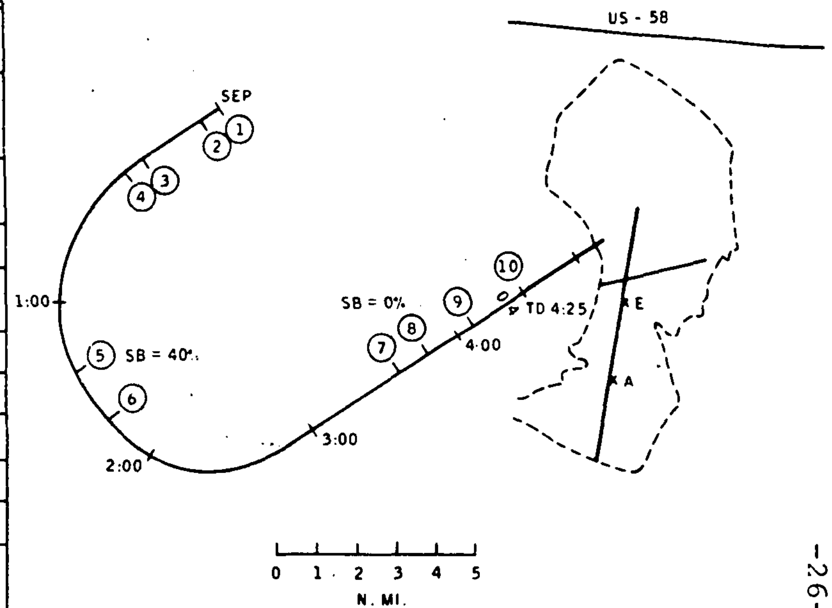
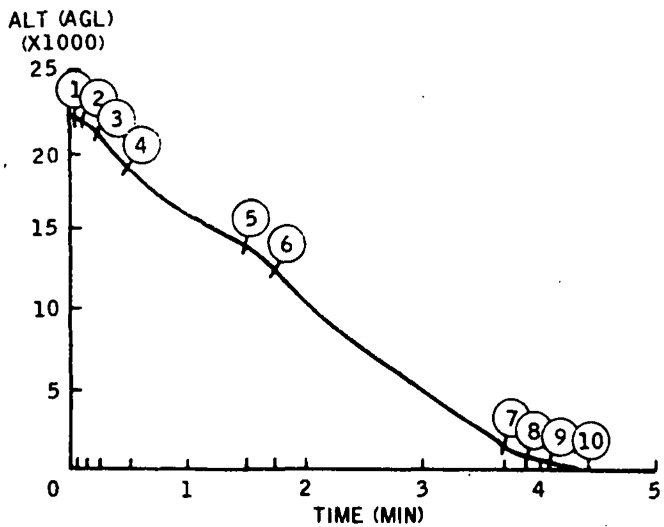
ALT FREE FLIGHT 5

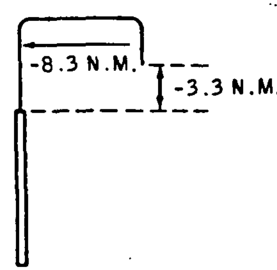
ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10°
3	0:18	20400	270	6	-10	AS = 265 $\dot{\theta}$ = 2°/SEC TO θ = -2 HOLD AS = 270
4	0:28	18900	270	6	-2	ROLL LEFT ϕ = 30°; HOLD AS = 270
5	1:28	14000	270	6	-2	AT ψ = 235° ROLL ϕ = 0° SB → 40% θ → -4 HOLD AS = 270
6	1:43	12600	270	6	-4	ROLL LEFT ϕ = 30 TO ψ = 045°
7	3:38	2000	270	6	-4	SB → 0
8	3:50	900	270	5	-9	INITIATE PREFLARE
9	4:05	350	250	6	4	AT AS = 250, DEPLOY GEAR
10	4:25	0	175	11	11	TD AS < 220; $\dot{h}$ < 10 fps
11	4:28	0	160	--	--	AT TD + 3 SEC, BRAKE HARD 5 SEC WAIT 5 SEC, BRAKE HARD 5 SEC WAIT 5 SEC
12	4:48	0	--	--	--	BRAKE AS REQUIRED





WT = 150,000

CG = 64.5% (1070.24)



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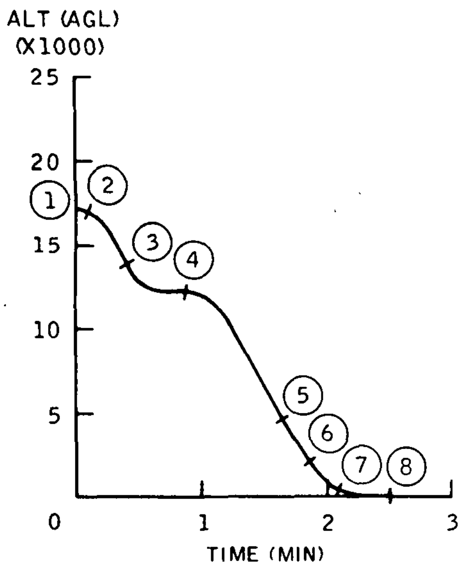
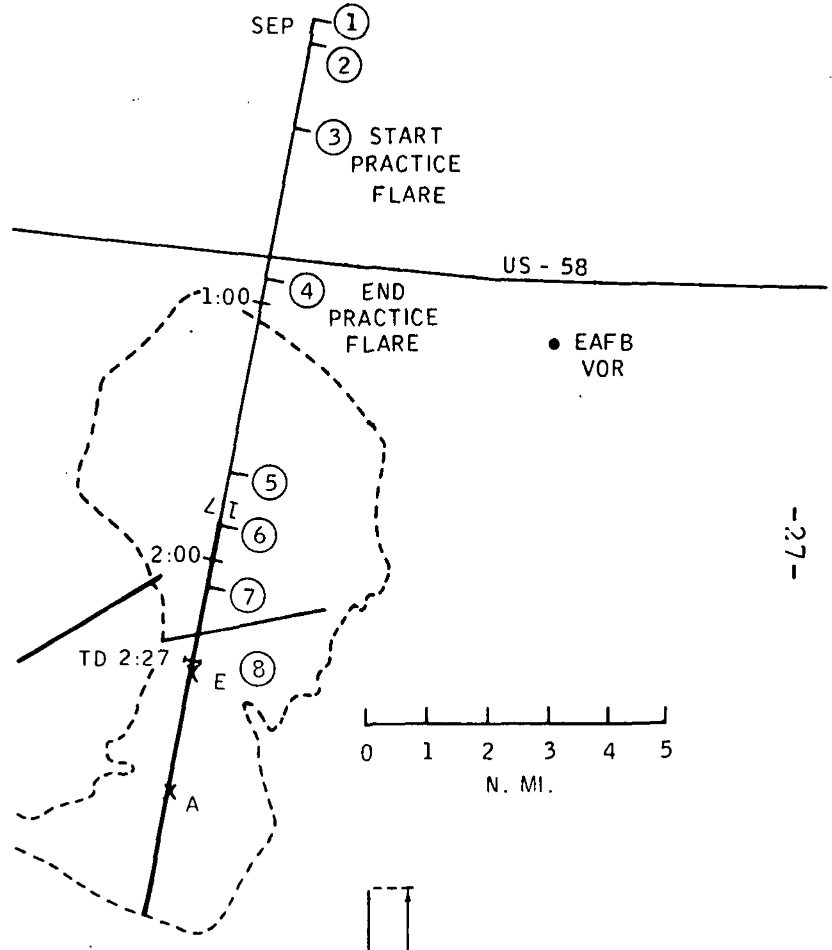
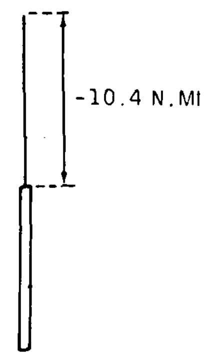
ALT FREE FLIGHT 6

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	17000	244	8	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -2°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -2°/SEC TO θ = -22°
3	0:23	14300	255	5	-22	AT AS = 255. INITIATE PRACTICE FLARE $\dot{\theta}$ = 2°/SEC, CONTINUE FLARE TO HOLD $\dot{h}$ = 0; AS = 185
4	0:55	12200	185	11	11	AT AS = 185; $\dot{\theta}$ = -2°/SEC TO θ = -22°
5	1:40	4600	285	4	-22	AT AS = 285 $\dot{\theta}$ = 1°/SEC TO θ = -17° TO HOLD AS = 290
6	1:52	2000	290	4	-17	INITIATE PREFLARE $\dot{\theta}$ = 2°/SEC
7	2:07	350	250	6	3	AT AS = 250 DEPLOY GEAR
8	2:27	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
9	2:30	0	160	--	--	BRAKE AS REQUIRED



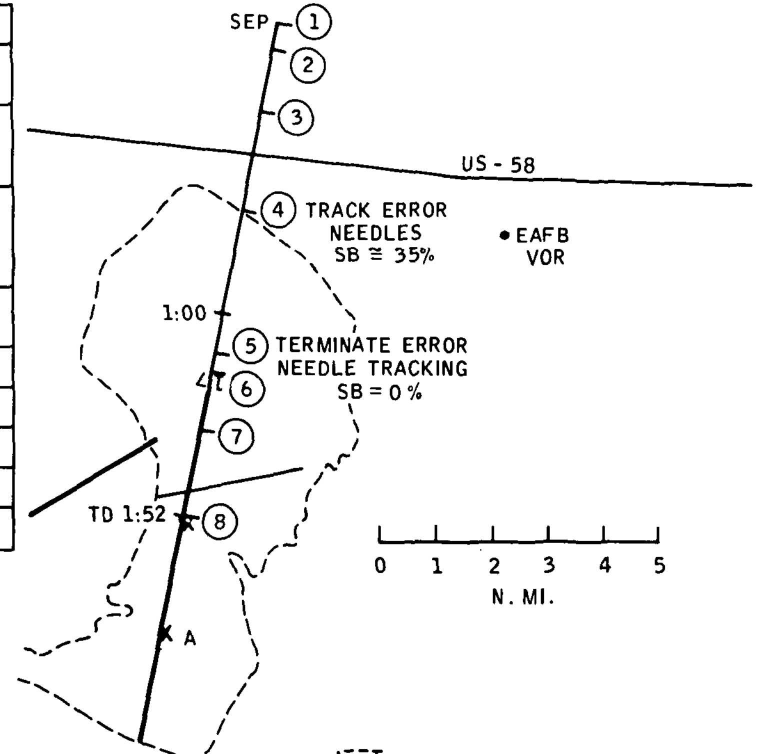


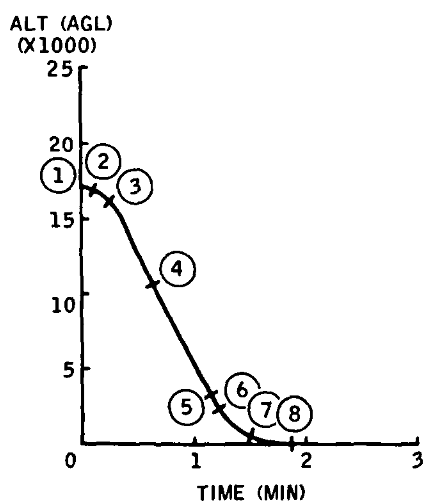
WT ~ 150,000
CG = 65% (1076.7)
TAILCONE OFF



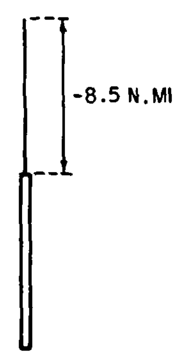
ALT FREE FLIGHT 7

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	17000	244	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -2°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -2°/SEC TO θ = -22°
3	0:18	15500	238	5	-22	$\dot{\theta}$ = 0; ACCELERATE TO 290, FLY GUIDANCE ERROR NEEDLES TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDESLOPE (θ = -20.5)
4	0:38	10400	290	4	-20.5	FLY GUIDANCE ERROR NEEDLES AND SB BRAKE COMMANDS ≈ 35%
5	1:10	3100	290	4	-20.5	SB → 0
6	1:15	2000	290	4	-20.5	INITIATE PREFLARE $\dot{\theta}$ = 2°/SEC
7	1:30	500	250	6	3	AT AS = 250, DEPLOY GEAR
8	1:52	0	175	11	11	TD AS < 220; $\dot{h}$ < 10 fps
9	1:55	0	160	--	--	BRAKE AS REQUIRED



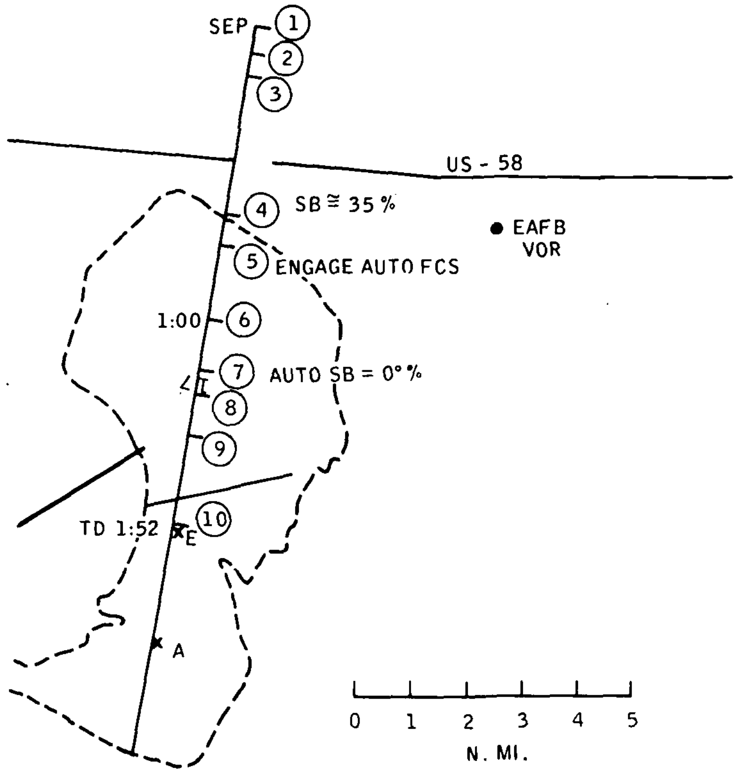


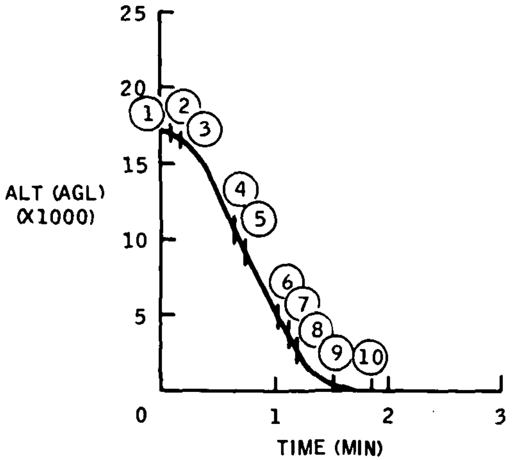
WT = 150,000
CG = 65% (1076.7)



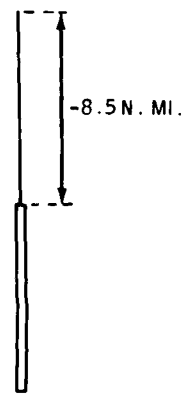
ALT FREE FLIGHT 8

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	17000	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -2°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -2°/SEC TO θ = -22°
3	0:10	15500	238	5	-22	$\dot{\theta}$ = 0; ACCELERATE TO 290, FLY GUIDANCE ERROR NEEDLES TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDESLOPE (θ = -20.5)
4	0:38	10400	290	4	-20.5	FLY GUIDANCE ERROR NEEDLES AND SB BRAKE COMMANDS ≈ 35%
5	0:44	9000	290	4	-20.4	WHEN THE GUIDANCE NEEDLES ARE CENTERED, ENGAGE AUTO FCS (WHICH INCLUDES AUTO SB)
6	1:00	5300	290	4	-20.4	CHANGE FCS TO CSS AND BACK TO AUTO (SET MAN SB TO CMDED PRIOR TO SWITCHING FCS MODES)
7	1:10	3100	290	4	-20.4	MONITOR AUTO SB RETRACTION
8	1:15	2000	290	4	-20.4	MONITOR PREFLARE
9	1:30	500	250	6	3	DEPLOY GEAR ON GEAR DEPLOY LITE OR 250 KEAS
10	1:52	0	175	11	11	MONITOR TD
11	1:55	0	160	--	--	BRAKE AS REQUIRED





WT = 150,000
CG = 65% (1076.7)



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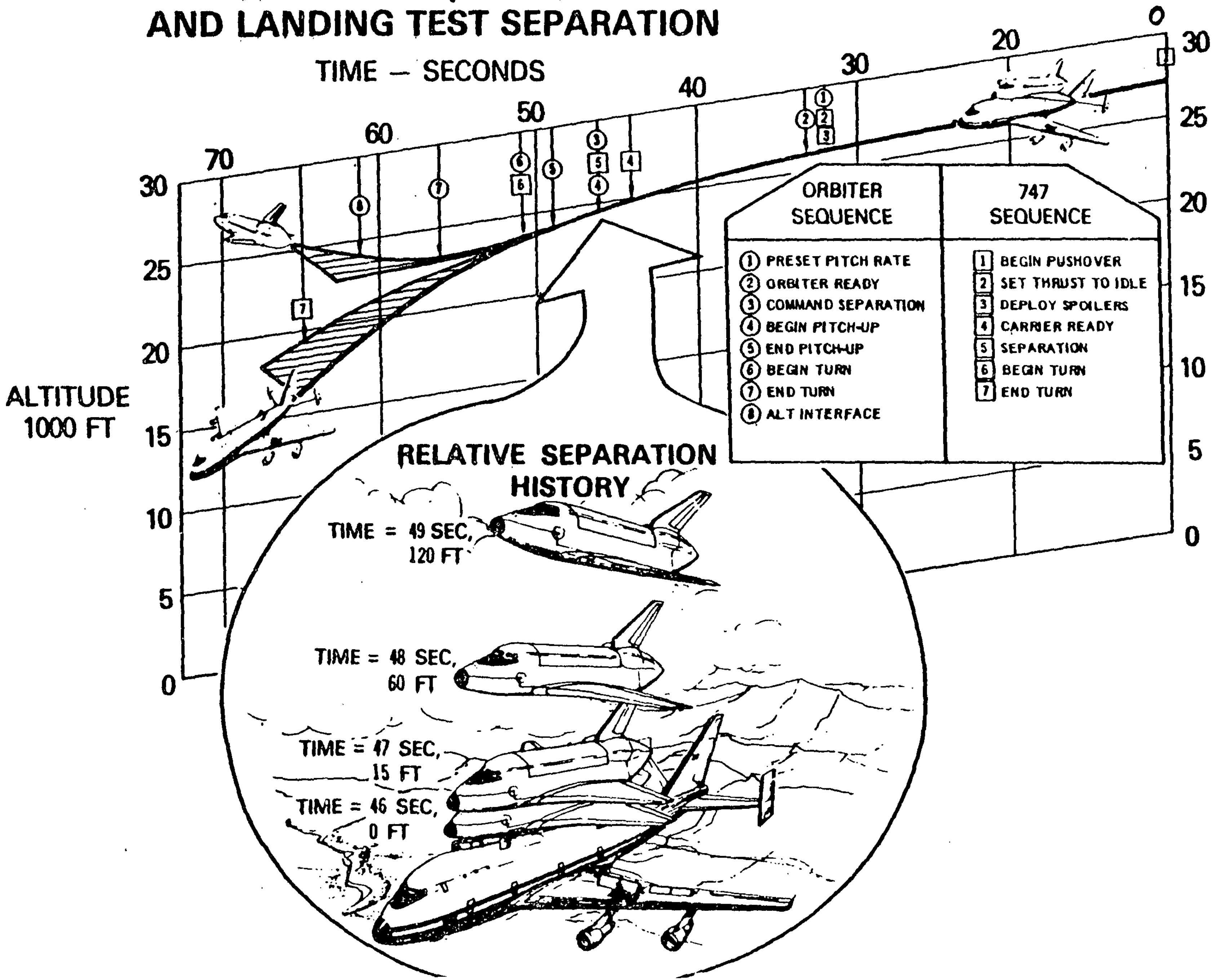
SHUTTLE ORBITER/747 APPROACH AND LANDING TEST SEPARATION



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APPROACH AND LANDING TEST TIMELINE

Orbiter Vehicle (OV-101) overland to Dryden Center	January 1977
Taxi runs and begin captive inert flights (6)	February 1977
Begin captive active flights (manned Orbiter) (5)	May 1977
Begin manned free flights (up to 8)	July 1977
Conclude ferry flight phase (3)	March 1978
Ferry flight to Marshall Center, Ala.	March 1978

GROUND VIBRATION TESTS

Orbiter 101 will be ferried from Dryden Flight Research Center, Calif.,to the Marshall Space Flight Center, Huntsville, Ala., for ground vibration tests in March 1978.

It will be mated in the Dynamic Test Facility at Marshall to the 46-m (154-ft.) tall external tank and solid boosters, as it would for actual launch. The tank in flight will carry the 675,000 kg (1.5 million lb.) of liquid hydrogen and liquid oxygen propellants for the Orbiter's three main engines. The two solid boosters will be attached to the external tank. This 56-m (184-ft.)-tall vehicle will undergo low level stress tests during the launch phase, when all the Shuttle engines -- the three main engines of the Orbiter and the two solid boosters -- fire simultaneously furnishing 30 million newtons (6.8 million lb.) of thrust.

The vibration tests are designed to gain information needed for analysis of flight control stability and dynamic loads during the launch and flight phases of the mission. The tests will be conducted in a modified test stand in which the entire 111-m (363-ft.)-tall Apollo Saturn V underwent similar vibration tests in the mid 1960s.

ORBITER AND SYSTEMS OV-101

The Enterprise, Orbiter 101, is comparable in size and weight to a modern transport aircraft. Its length is 37.2 m (122 ft.), wing span 23.8 m (78 ft.), and weighs approximately 68,000 kg (150,000 lb.).

All the Orbiter systems, including avionics, communications, crew equipment environmental control, electrical control and power necessary for the Approach and Landing Test program (ALT), are aboard the vehicle, It lacks the three main engines (three dummy engines are installed), the reaction control system and the orbital maneuvering systems. In addition, simulated tiles are used in place of the thermal protection system which will be used on the orbiters during Earth Orbital flights.

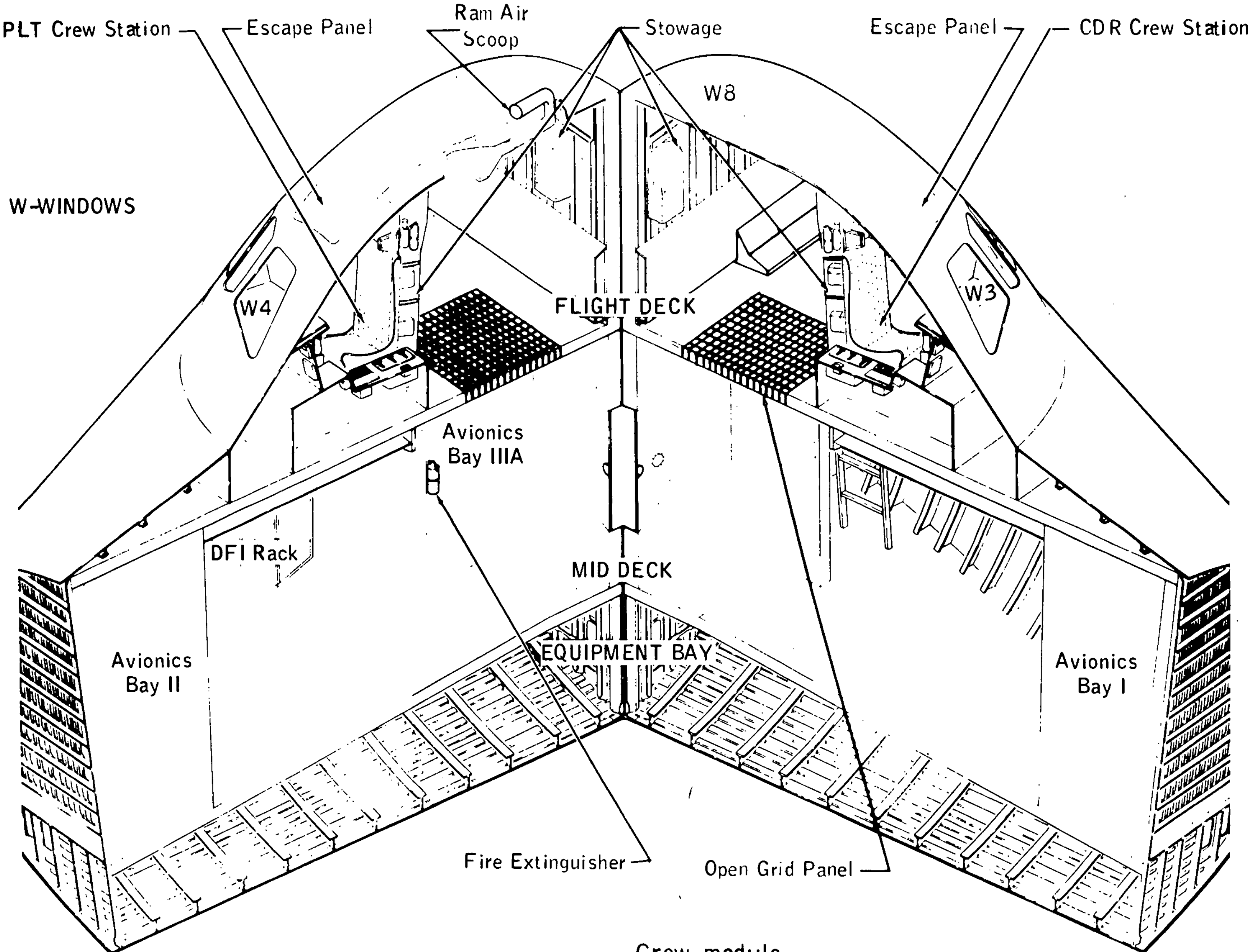
The aerodynamic control surfaces - the body flap at the aft end of the Orbiter, the wing elevons and the rudder/speed brake - provide the control of the Orbiter during the atmospheric portions of the flight. Landing speed of the Orbiter is approximately 185 knots (343 km/hr.),which parallels the performance of current high-performance aircraft.

The majority of the Orbiter structure is of conventional aluminum construction, covered with reusable surface insulation.

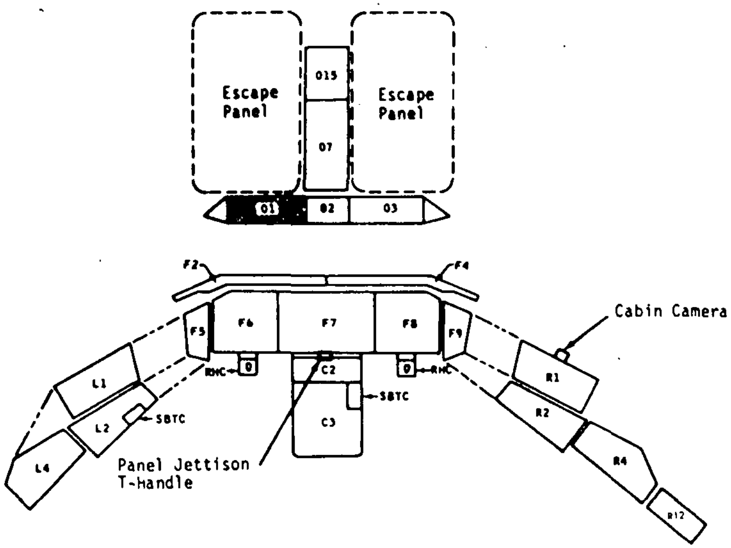
The Orbiter consists of the forward fuselage, the mid fuselage, aft fuselage, wing and vertical tail assembly. These major subassemblies are mated and joined to form the 37.2 m (122 ft.)-long vehicle.

Forward Fuselage and Crew Module - The forward fuselage structure is conventional aircraft construction of 2,024 aluminum alloy skin/stringer panels, frames and bulkheads. The crew module which has a volume of 61 cubic meters (2,150 cubic feet) has three levels or sections - flight deck, the mid-deck and lower section. The crew module is welded construction of aluminum alloy integrally machined panels and floats free within the forward fuselage.

Flight Deck - The flight deck consists of two flight stations; the commander's station which is located on the port side and the pilot's station located on the starboard side of the Orbiter. The displays and controls required for normal and emergency operations for all flights phases are located around the two flight stations. The controls are arranged so that a single crewman operating from either station can land the Orbiter.


PLT Crew Station
Escape Panel
Ram Air Scoop
Stowage
Escape Panel
CDR Crew Station
W8
W-WINDOWS
W4
W3
FLIGHT DECK
Avionics Bay IIIA
DFI Rack
MID DECK
EQUIPMENT BAY
Avionics Bay II
Avionics Bay I
Fire Extinguisher
Open Grid Panel

Crew module.



PANEL NUMBER	DISPLAYS & CONTROLS
O2	• Fuel Cell Meters • Cabin Pressure
O3	• Fuel Cell Purge • Computer Status
O7	• Computers
O15	• Interior Lighting
C2	• CRT Keyboards
C3	• Flight Control System Channel • Air Data Probe • Communications/Navigation • Trim/Body Flap • Inverter/Fuel Cell Circuit Breakers
F2	• Flight Control Modes (Commander's) • Events Sequence (Commander's)
F4	• Flight Control Modes (Pilot's) • Events Sequence (Pilot's)
F5	• 8-Day Clock (Commander's) • Primary Flight Control System Reset
F6	• Commander's Primary Flight Instruments • Landing Gear
F7	• CRT's • Caution & Warning • Surface Position Indicators • Backup Flight Control Displays • Fire Protection
F8	• Pilot's Primary Flight Instruments • Auxiliary Power Unit/Hydraulics Displays • Landing Gear
F9	• 8-Day Clock (Pilot's) • Right Controller Power
L1	• Environmental Control & Life Support System • Operational Instrumentation
L2	• Trim/Body Flap • Audio • Cabin Temperature
L4	• Circuit Breakers
R1	• Power Distribution • Development Flight Instrumentation
R2	• Hydraulics/Auxiliary Power Unit • Fuel Cell • Audio
R4	• Circuit Breakers
R12	• Hydraulics • Auxiliary Power Unit Heaters • Caution & Warning • Utility Power Outlet

Two ejection seat systems are installed in the flight station and are used for crew seating during normal operations and for emergency escape.

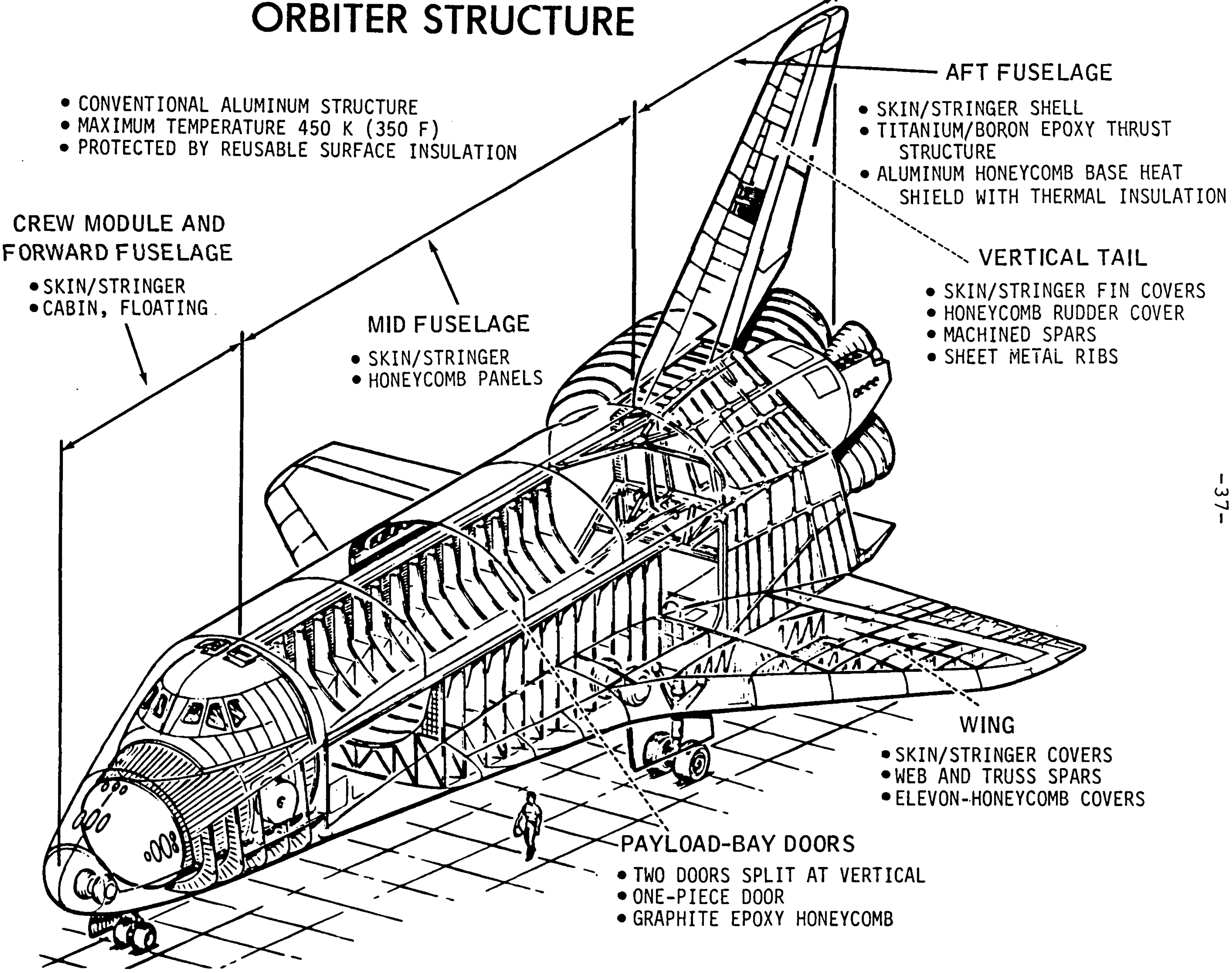
Mid-Deck - The electric and electronic control equipment of the Orbiter are contained in the avionic bays of the mid-deck. Normal crew ingress-egress and emergency egress is provided by a 1.02-m-(40-inch) diameter hatch located on the port side of the mid-deck. In the operational vehicles, the mid-deck constitutes the living quarters of passengers and crew.

Lower Section - The lower section contains the equipment bay which houses the environmental control and life support system (ECLSS) necessary to control cabin and avionics bay temperature, humidity and to distribute conditioned air to the cabin.

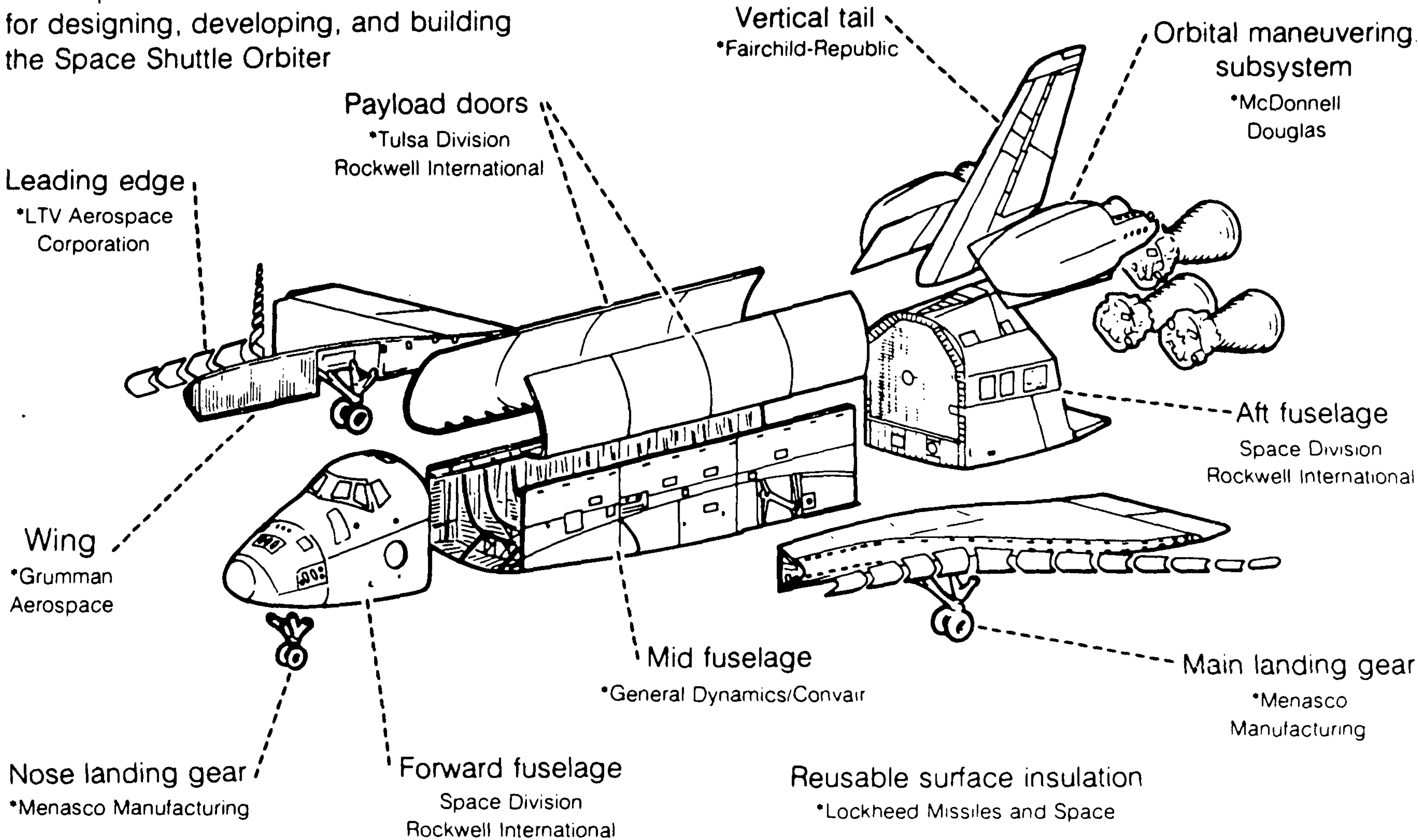
Mid Fuselage - The mid fuselage, similar in construction to the forward fuselage, is a section 18.6 m (61 ft.) which provides the support for the Orbiter payloads. Two payload bay doors of graphite epoxy honeycomb construction fit atop the mid fuselage forming a cargo bay of 18.3 x 4.6 m (60 ft. x 15 ft.).

Aft Fuselage - The aft fuselage is approximately 5.49 m (18 ft.) long, 6.7 m (22 ft.) wide and 6.1 m (20 ft.) high. The aft fuselage supports and interfaces with the removable OMS pods, two wing spars, vertical tail assembly, body flap, two external tank aft attachments the three main engines and three avionics bays.

ORBITER STRUCTURE



The Space Division of Rockwell International
is also prime contractor to NASA
for designing, developing, and building
the Space Shuttle Orbiter



*Orbiter subcontractors (contracts with Space Division)

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ORBITER SYSTEMS

Electrical, Environmental and Mechanical

Three fuel cells will provide electrical power for the Enterprise, as for all subsequent vehicles. For ALT only, gaseous oxygen and hydrogen will replace cryogenics for the fuel supply. Sufficient quantities for oxygen and hydrogen will allow for 208 minutes of electrical power operation.

The atmospheric revitalization system consists basically of the cabin fans and a special ram air vent system (just for ALT) for cabin air purification. The Orbiter's active thermal control system for ALT consists of a series of Freon loops which are cooled by an ammonia boiler supplied by six special add-on tanks located in the cargo bay.

Three auxiliary power units (APU) and hydraulics (HYD) units, essentially the same as those on subsequent vehicles, will provide hydraulic power for operation of the aerodynamic control surfaces (body flap, elevons, rudder/speed brake) and the landing gear. Sufficient fuel (hydrazine) for the power units and hydraulic cooling water will be carried aboard the vehicle to allow 129 minutes of system operation.

Guidance, Navigation and Control (GN&C)

Three inertial measurement units (IMUs) are installed to provide output signals proportional to both vehicle attitude and velocity changes. Analog measurements of the angular rates about the vehicle pitch, roll and yaw axes will be furnished by three rate gyro assemblies (three per axis).

Six body-mounted accelerometers-three for the normal axis and three for the lateral axis-will furnish analog measurements of the acceleration.

Three microwave scanning beam landing systems (MSBLS) are aboard the ALT vehicle to provide elevation, azimuth and range data relative to ground based MSBLS systems for automatic landing.

Other GN&C systems on the first Orbiter are: air data transducer, nose boom, tactical air navigation, radar altimeter, backup flight control system and five general purpose computers.

Communications and Tracking Subsystems

The communications and tracking system for the ALT Orbiter consists of a UHF voice communications subsystem, an Orbiter/Shuttle Carrier Aircraft (SCA) intercom, an S-band Frequency Modulation (FM) transmitter and antenna subsystem for downlinking Orbiter operational instrumentation (OI) and Development Flight Instrumentation (DFI) and a C-band radar beacon and antenna subsystem.

Crew Equipment - Orbiter

The ALT crewmen aboard the Orbiter will wear standard low altitude flight clothing. The flight clothing consists of the basic suit, helmet, boots, and gloves.

The helmet is a customized flying helmet which contains earphones, an earphone jack receptable, an adjustable sunshade-visor and two receivers for oxygen mask attachment. The flight suit is fabricated from Nomex material and contains pockets for pens, pencils, and other ancillary equipment.

Shuttle Carrier Aircraft (SCA)

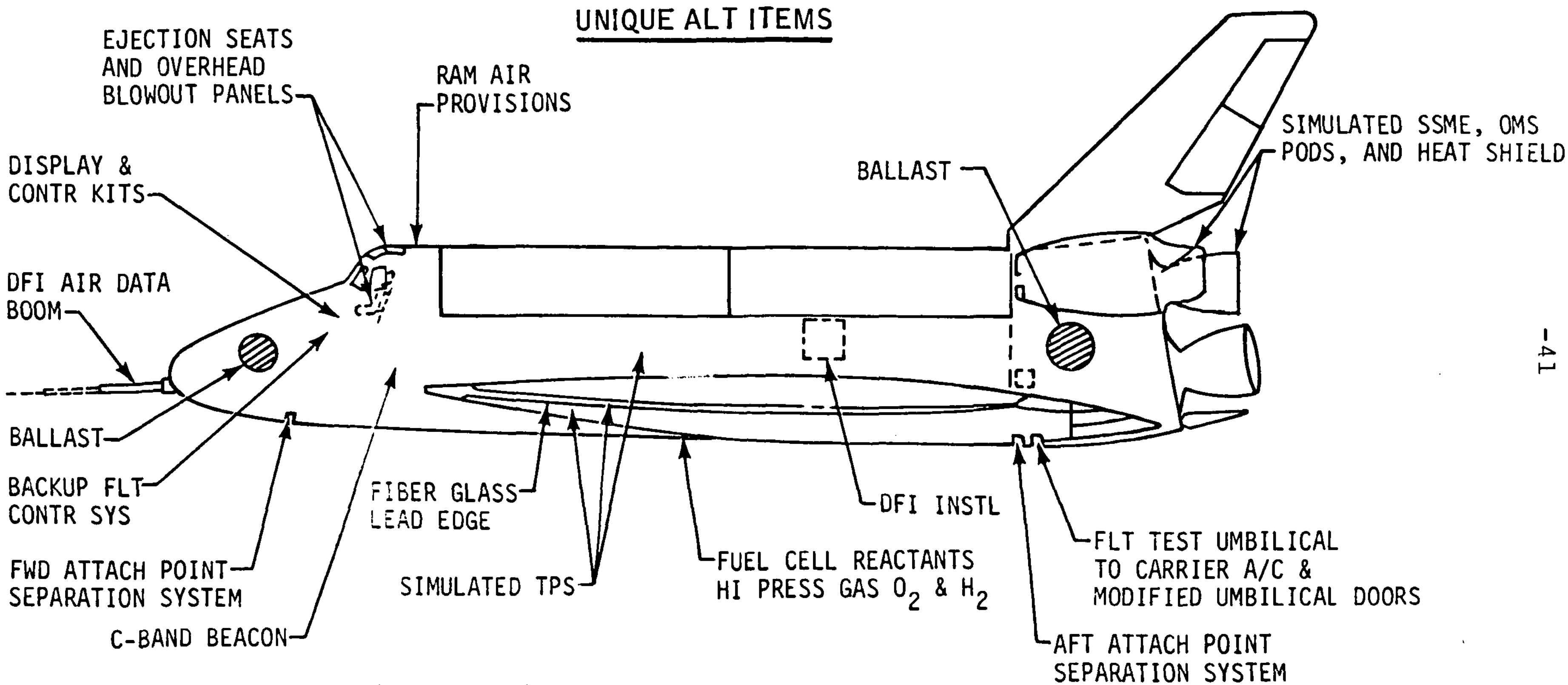
The SCA, a Boeing 747, purchased by NASA in the summer of 1974, has been modified at the manufacturer's facilities in Everett, Wash. The 70.4-m-(231-ft.-) long aircraft has had the majority of its seats and passenger accommodations replaced by equipment and instruments required to support the Orbiter test flights. Structural modifications include addition of reinforcement frames and panels. Panels and stabilizer tip fins have been attached to the horizontal stabilizer.

Support struts (two aft, one forward) have been added to the aircraft to hold the Orbiter. The Orbiter will be affixed to these points and, at the proper moment in flight, explosive bolts will release the Orbiter from the SCA.

In addition to serving as the carrier aircraft for the approach and landing tests, the 747's primary purpose is to ferry the Orbiter from Dryden to the NASA Kennedy Space Center launch facilities in Florida. The SCA will also be used to ferry the Orbiter to launch facilities at Vandenberg Air Force Base, near Lompoc, Calif.

ORBITAL SYSTEMS NOT INSTALLED

- OMS
- RCS
- SSME'S
- EPS CRYO TANKS
- PAYLOAD ACCOM
  - WATER, WASTE, & FOOD MGMT SYSTEM
- RADIATORS
- TPS
- CREW STATION
  - PAYLOAD SPEC
  - ON ORBIT
- STAR TRACKERS
- UNIFIED S-BAND
- RENDEZVOUS RADAR AND KU-BAND



NOTE: Orbiter shown without tailcone

OV 101 configuration for ALT.

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In addition to the modifications necessary for the 747 to serve as a carrier and ferry aircraft, an emergency escape system has been added to the former passenger jetliner.

The modifications include a quick exit for flight crews and other personnel through a tunnel which has been installed directly behind and below the flight deck. This exit tunnel extends from the flight deck level to the bottom side of the 747. The 81 centimeter (32-inch)-diameter tunnel has been equipped with an aerodynamic spoiler which will be extended below the aircraft to aid personnel in exiting beneath the airstream of the 747. Individual parachutes will be provided for all those aboard the 747.

Flight Control Operations

Real time flight control functions will be performed by flight controllers located at Dryden Center for the captive inert flights and the Johnson Space Center, MCC-H for those flights in which the Orbiter is manned.

Inert Flights - Dryden

"NASA 1," the call sign of the control room at Dryden Flight Research Center, has been used for the flight control of such experimental aircraft as the X-1E, X-15, XB-70 and other flight research programs. It is the prime control room for the inert phase of ALT.

The room is four separate areas; the dynamic analysis room, the mission analysis room, the telemetry processing room and the flight monitoring room. The first three rooms receive inflight data that is necessary for the safe control of the flight.

Two large radar plot boards are located in the flight monitoring room which trace the track of the SCA/Orbiter to aid the flight controller in guiding the SCA/Orbiter throughout the test maneuvers and to the launch point.

The room is manned by a joint government/industry team of engineers. Communications between the flight crew and the room are restricted to the flight controller.

Active Flights - MCC-H (Mission Control Center - Houston)

All Orbiter and 747 instrumentation data will be recorded onboard the respective vehicles. Other selected Orbiter and 747 data, including selected wideband data, will be transmitted to and recorded on the ground.

Orbiter operational instrumentation and development flight instrumentation and limited 747 data will be sent to the MCC-H as well as realtime ground radar data and voice communication (Orbiter, 747 and chase aircraft) will be transmitted to MCC-H.

The flight control team at JSC is headed by the ALT Flight Director who will direct the test activities to insure that the flight test is providing the best possible returns in relation to test objectives and is being accomplished consistent with flight safety.

The MCC-H ALT flight team consists of the following Flight Test Engineers (FTE):

- EECOM - (Electrical, Environmental and Mechanical) This FTE is responsible for operational knowledge, evaluation and monitoring of hydraulic electrical, environmental and mechanical systems of the Orbiter. He will be assisted by one additional test engineer.

- GNC - (Guidance, Navigation and Control) The GNC FTE is responsible for guidance, navigation and control systems of the Orbiter. The GNC will be supported by three additional test engineers.

- INCO - (Instrumentation and Communication) The INCO test engineer is responsible for the Orbiter instrumentation and communication and in addition he is responsible for handling onboard and ground communication anomalies when they occur. He will be assisted by one test engineer.

- FIDO - The Flight Operations Engineer or FIDO is responsible for monitoring the trajectory and onboard navigation and guidance, including the operation of related software.

- NETWORK - The network controller is responsible for the operational direction and control of the S-band/L-band ground station (Buckhorn) and the MCC-H ground instrumentation systems and personnel.

ORBITER/SCA MATED CONFIGURATION

ENGINES

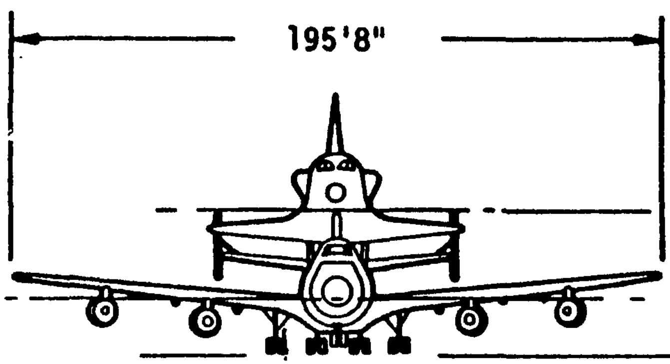
P & W JT9D-7AH

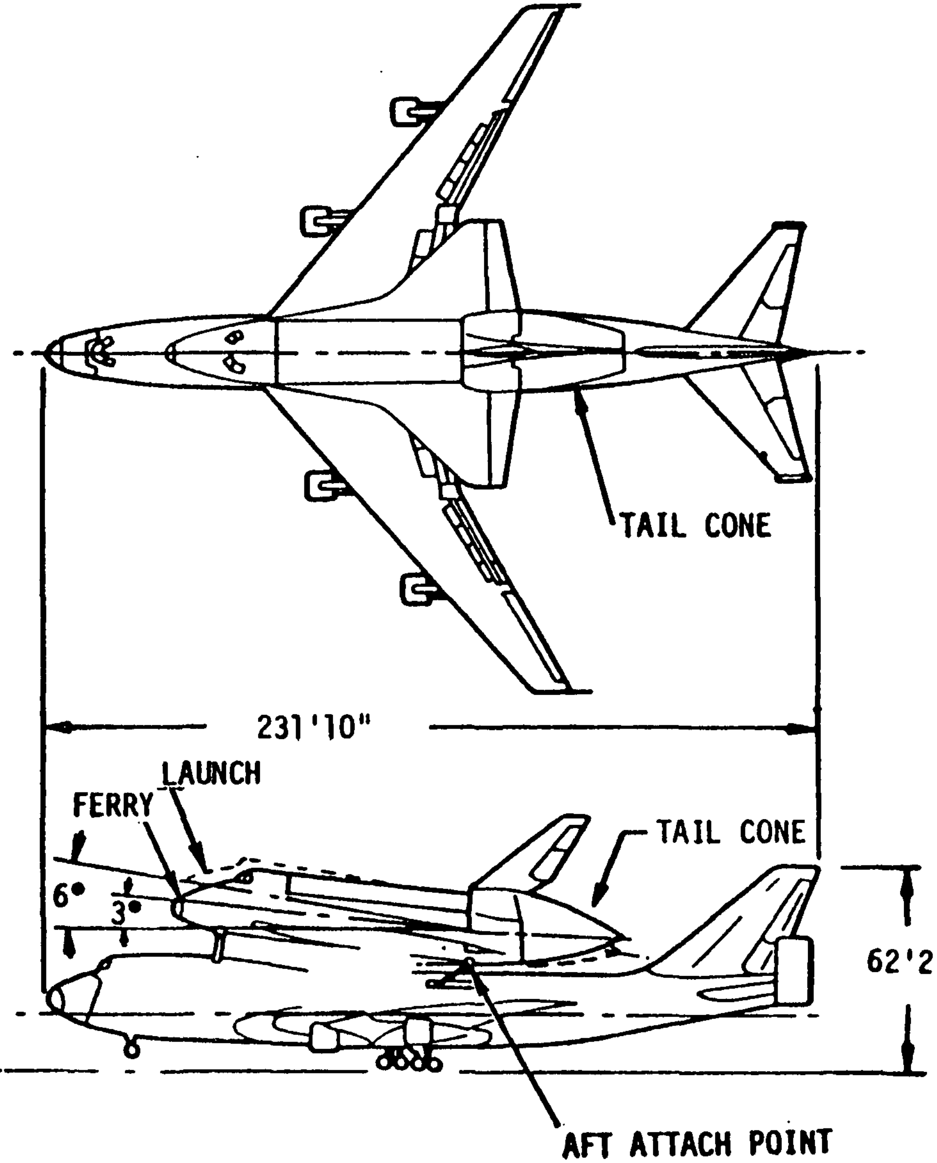
MAX THRUST (TAKEOFF)-46,950 LB PER ENGINE

WEIGHT

SCA

- MAX. TAXI GROSS WT. - 738,000 LB.
- MAX. LANDING WT. - 564,000 LB.





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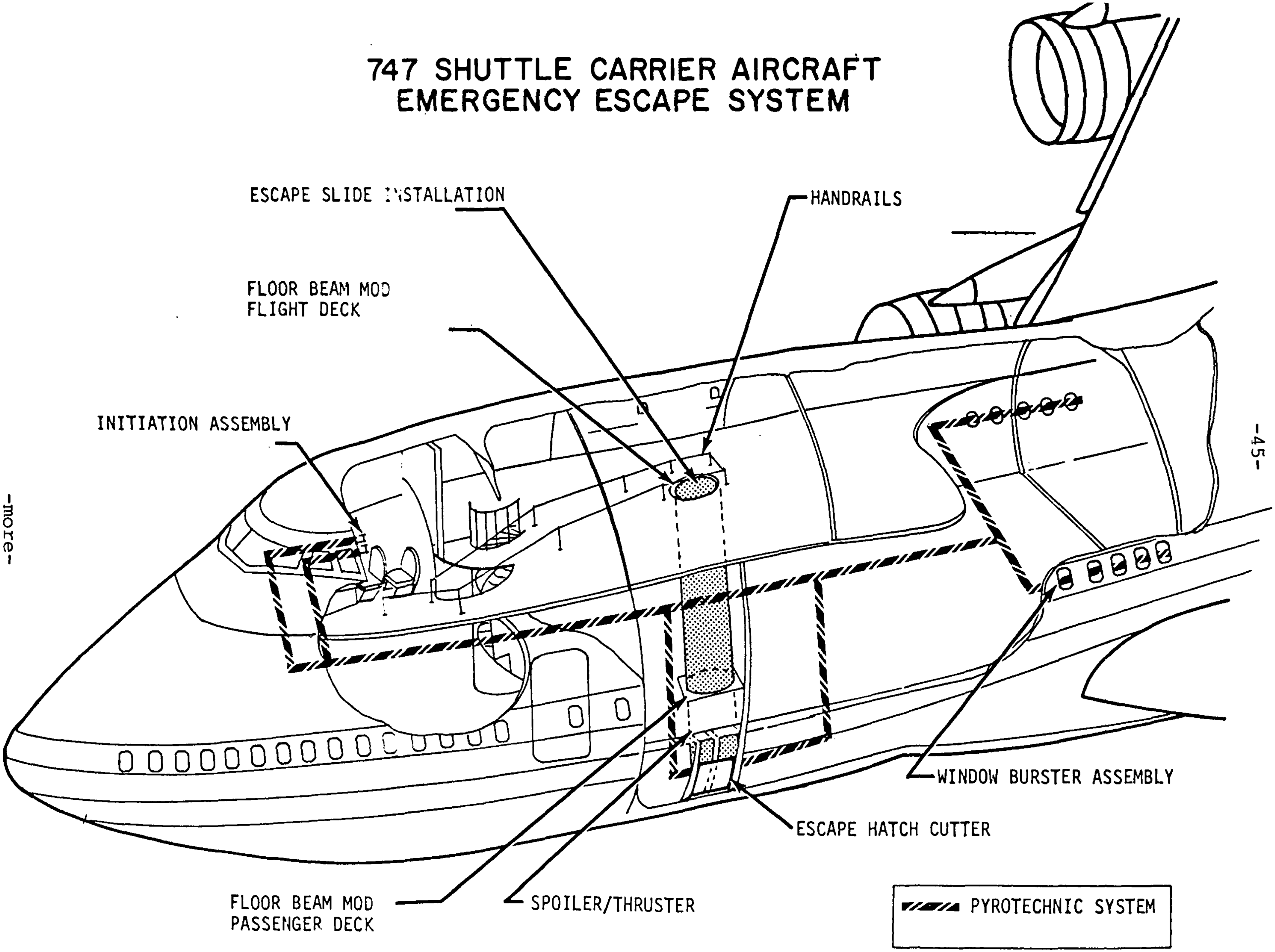
747 SHUTTLE CARRIER AIRCRAFT EMERGENCY ESCAPE SYSTEM



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• CAPCOM - (Capsule Communicator) The air-to-ground communicator will perform the traditional role of voice communications with the Orbiter, 747, chase aircraft crews and some ground support equipment during all phases of the flight.

• S&C - (Stability and Control) The stability and control officer is responsible for assuring the vehicle flight characteristics are within planned operational limits.

• L&D - (Loads and Dynamics) The Loads and Dynamics test engineer will monitor the attach point loads between the Orbiter and 747 during mated flight and the Orbiter loads during free flight.

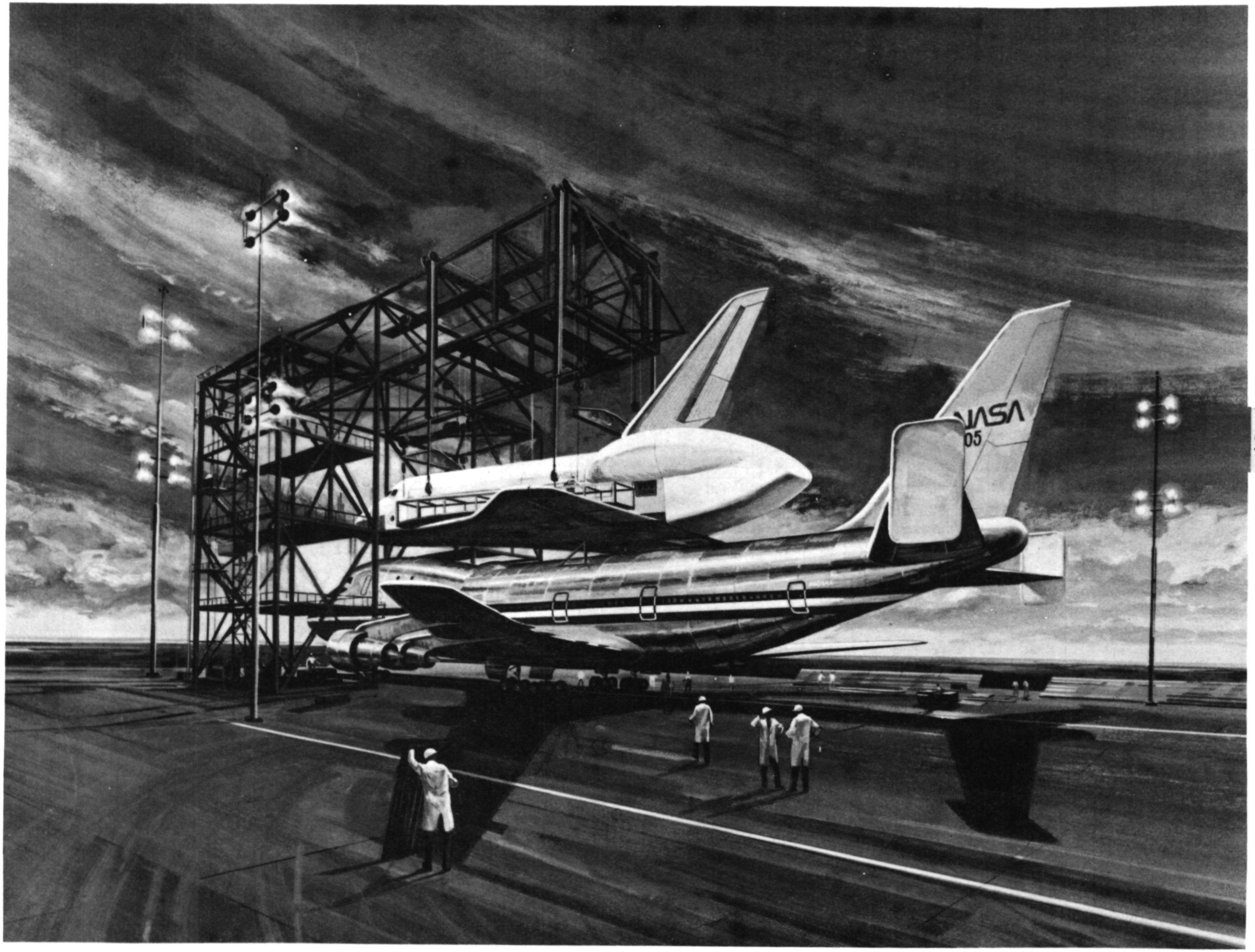
• RANGE - The Range coordinator will interface with both the Network Controller and the Flight Operations Engineer during realtime operations.

Facilities at Dryden and Edwards AFB

Runway Complex

There is a hard-surface runway at Edwards Air Force Base, runway 4-22, which is 4,572 m (15,000 ft.) long and 91 m (300 ft.) wide. When landing to the northeast on runway 4, there is an overrun that extends to the dry lakebed.

Rogers Dry Lake is 168 square km (65 square mi.) (normally) dry lake bed with seven marked runways. The longest runway, 17-35, is 12 km (7.5 mi.) long and has been selected as the prime landing site for the free flights of the Shuttle. Two lakebed runways are 91 m (300 ft.) wide and marked X to aid the pilots.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Mate/Demate Device

The Mate/Demate Device (MDD) provides the hoisting capability for lifting the Shuttle Orbiter during mating or demating operations on the 747.

The main steel structure consists of two 30-m (100-ft.) tall towers with platforms at 6, 12, 18 and 24 m (20, 40, 60 and 80 ft.) on each tower, and a horizontal structure mounted at 24 m (80 ft.) between the towers. This horizontal structure cantilevers out 21 m (70 ft.).

Three 45,360-kg (100,000-lb.) hoists connected to a lift beam provide hoisting capability. Two hoists are connected aft and one hoist forward. The three hoists operate simultaneously in the lifting operation.

To service the Orbiter during Approach and Landing (ALT) operations, two service access platforms are provided, one on each side of the Orbiter. The platforms are normally stored when not in use at the 18-m (60-ft.) level and are lowered to the Orbiter by two telescoping tubes mounted on the cantilever section.

Two equipment hoists, each capable of carrying 4,360 kg (10,000 lb.) or 25 people, are installed on each tower. These hoists operate to the 18-m (60-ft.) level.

The MDD was designed by Connell Associates, Inc., of Coral Gables, Fla., and constructed by the George A. Fuller Co., Chicago, Ill., for a construction cost of $1,700,000.

The ALT hangar is a single bay hangar with two 22,680-kg (50,000-lb.) bridge cranes. Dimensions of the hangar are 54 x 43 x 24 m (176 x 140 x 80 ft.) high. A shop annex of 622 square m (6,700 square ft.) for tools, supplies and equipment is located on the north side of the hangar.

An 18-m (60-ft.) wide, 38-cm (15-in.) thick paved towway connects the hangar, the MDD and the existing airfield pavement at Dryden Center.

The hangar was designed by Voorheis, Trindle and Nelson (VTN) of Irvine, Calif., and constructed by Santa Fe Engineers, Inc., Lancaster, Calif., at a construction cost of $3,700,000.

PHOTOGRAPHY AND TELEVISION

Photographic equipment used during the Shuttle Approach and Landing Tests includes still and television cameras for air-ground coverage and still and motion picture cameras for onboard coverage. The television cameras will have the capability to produce a live picture or a delayed playback with the use of video tape recorders (VTR).

The equipment will record the takeoff, orbiter-carrier separation, crew activities, approach and landing of the orbiter craft.

Television sources consist of one color camera mounted in the T-38 chase plane; one color camera mounted atop the Mobile TV Van; a color Long Range Optics camera (LRO); a camera equipped helicopter (KNBC); and a portable camera to be used as a backup to the T-38 chase plane.

Ten 16 mm cameras using medium speed color film are located in the cabin, landing gear wells and orbiter-carrier attachment points. These cameras will photograph inflight and landing activities. There will be no onboard television cameras during ALT.

Twelve color TV monitors are located in the DFRC News Center and Press working area. The monitors will be fed "best source" video.

SPACE SHUTTLE ALT CREWS

NASA has selected two two-man crews for the Space Shuttle Approach and Landing Test (ALT), the initial flight test of the Shuttle Program. The ALT free flight tests are scheduled to begin in July 1977.

The two crews are: Fred W. Haise, Jr., commander and Charles G. Fullerton, pilot; Joe H. Engle, commander and Richard H. Truly, pilot. Both crews are scheduled to fly ALT missions, with Haise and Fullerton making the first flight.

The crews will participate in the various phases of orbiter test and checkout between now and the first flight. Both crews will train for the flights using the Shuttle Training Aircraft, a modified, twin jet Gulfstream II and the Orbiter Aeroflight Simulator.

Haise, 42 (civilian), commander of the first crew was selected for the astronaut program in April 1966. He was backup lunar module pilot for Apollos 8 and 11, lunar module pilot on Apollo 13 and backup commander on Apollo 16 He is the only crewman named that has flown in space.

Fullerton, 39 (Lieutenant Colonel, USAF), pilot of the first crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crews for the Apollo 14 and 17 missions.

Engle, 43 (Colonel, USAF), commander of the second crew, was selected for the astronaut program in April 1966. He was a member of the astronaut support crew for Apollo 10 and the backup lunar module pilot for the Apollo 14 mission.

Truly, 38 (Commander, USN), pilot for the second crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crew for all three Skylab missions.

747 CARRIER AIRCRAFT CREW

Crew members for the 747 carrier aircraft are Fitzhugh L. Fulton, Jr. and Thomas C. McMurty, pilots; Victor W. Horton and Thomas E. Guidry, Jr., flight test engineers.

Fulton, McMurty and Horton are from the NASA Dryden Flight Research Center and Guidry is a flight engineer from NASA's Johnson Space Center.

Fulton is a veteran multi-engine test pilot with wide experience as a launch pilot. He was launch pilot for the X-15 and for manned lifting bodies, as well as on other experimental aircraft flight test programs. He was an XB-70 project pilot for NASA and the USAF. Currently Fulton is co-project pilot on the triple-sonic YF-12A flight research program.

McMurty has been flying experimental aircraft for NASA since 1967. As project pilot on the Supercritical Wing, he made the first flight with the new airfoil shape. He has flown as co-project pilot on the Digital Fly-by-Wire aircraft and the Supercritical Wing F-111, and as co-project pilot on NASA's 990 and C-141 multi-engine aircraft.

Horton is flight test engineer on the YF-12A at DFRC and has flown as launch panel operator of the B-52A air launch aircraft. Guidry of JSC has flown as test engineer on the C-135 Zero-G studies and the C-130 Earth Resources aircraft.

PROGRAM MANAGEMENT

Overall direction of the Space Shuttle Program is in the Office of Space Flight at NASA Headquarters, Washington, D.C. This office is responsible for the detailed assignment of responsibilities, basic performance requirements, control of major milistones and program funding.

The Lyndon B. Johnson Space Center (JSC), Houston, Tex., is the Space Shuttle lead center and has responsibility for systems engineering and systems integration. JSC is also responsible for development, production, and delivery of the Shuttle Orbiter.

The John F. Kennedy Space Center (KSC), Fla., is responsible for the design of launch and recovery facilities and will serve as the launch site. Edwards AFB, Calif., is the landing site for the first several Shuttle orbiter test flights.

The George C. Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for the development, production, and delivery of the Orbiter main engines, the solid rocket boosters and external tank for the hydrogen/oxygen fuel.

Some of the 747 Shuttle Carrier Aircraft Tests and all of the Orbiter Approach and Landing Tests will be conducted at the Dryden Flight Research Center, Edwards, Calif.

SPACE SHUTTLE PROGRAM OFFICIALS

JOHN F. YARDLEY, Associate Administrator for Space Flight, NASA Headquarters, directs NASA's space flight programs, including the Space Shuttle, the United States' efforts in Spacelab, expendable launch vehicles and the engineering studies related to possible future space flight projects. Born in St. Louis, Mo., in 1925, he received a B.S. degree in aeronautical engineering from Iowa State College and an M.S. degree from Washington University. After three years in the Navy during World War II, Yardley joined McDonnell Douglas in 1946 as a structural engineer. From 1958 to 1960, he served as Project Engineer for Mercury spacecraft design; and from 1960 to 1964, he was Launch Operations Manager for the Mercury and Gemini spacecrafts. He was Gemini Technical Director from 1964 to 1967 and Vice President and corporate-wide General Manager for the Skylab project prior to being Vice President and Deputy General Manager, Eastern Division, Astronautics, in 1968. Yardley then became Vice President and General Manager of the Division in 1973 at which position he remained until his appointment to NASA in 1974.

Dr. MYRON S. MALKIN is the Space Shuttle Program Director located at NASA Headquarters. Named to this post in April 1973, he heads overall design, management, integration, development and testing of the Space Shuttle. Dr. Malkin joined NASA after serving as Deputy Assistant Secretary of Defense for Technical Intelligence Evaluation for almost one year. He was president of NUS Corp., an engineering consultime firm, from 1969-71 and earlier held positions as program manager for Titan II and Minuteman III. He was general manager of the Manned Orbiting Laboratory (MOL) program at General Electric from 1961-69. Dr. Malkin was born in Youngstown, Ohio and received B.S., M.S. and Ph. D. degrees from Yale University.

ROBERT F. THOMPSON, the Space Shuttle Program Manager, is located at the NASA Johnson Space Center (JSC). He is responsible for management and integration of major elements of the program. Thompson was appointed to this position in 1970, after serving as manager of the Skylab program through the conceptual design and development phases. He joined NASA's predecessor organization, NACA, in 1947, and was selected as one of the early members of the Space Task Group, the nucleus of JSC. He was chief of the Landing and Recovery Division for Mercury, Gemini, and early phases of the Apollo program, prior to managing the early Skylab effort. He is a recipient of NASA's Outstanding Leadership, Exceptional Service and Distinguished Service medals. Born in Bluefield, Va., Thompson graduated from Virginia Polytechnic Institute with a B.S. in aeronautical engineering.

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AARON COHEN is manager of the Space Shuttle Orbiter Project located at NASA's JSC. He is responsible for design, development, production and testing of the Orbiter. He joined NASA at JSC in 1962 as a member of the Apollo Program Office and subsequently held varied executive posts in the program. He was appointed Command and Service Module (CSM) manager in 1970, directing CSM efforts on both Apollo and Skylab programs until his appointment to the Space Shuttle post in 1972. Cohen has earned two NASA Exceptional Service Awards, the NASA Certificate of Commendation and the NASA Distinguished Service Medal. Born in Corsicana, Tex., he has a B.S. in mechanical engineering from Texas A&M and an M.S. in applied mathematics from Stevens Institute of Technology.

DONALD K. SLAYTON is Manager for the Approach and Landing Tests Space Shuttle Program Office at JSC. He has overall program responsibility for managing the approach and landing test efforts and is responsible for integration of these activities at JSC, KSC and DFRC and other NASA Centers as required. Slayton was docking module pilot during the Apollo Soyuz Test Project in July 1975. He joined NASA as one of the original seven astronauts in 1959 and until his assignment to the ASTP crew, served as Director of Flight Crew Operations at JSC. He is the recipient of two NASA Distinguished Service Medals, the NASA Exceptional Service Medal, the Collier Trophy and numerous other honors from universities and organizations. A native of Sparta, Wis., Slayton is a graduate of the University of Minnesota where he received a Bachelor of Science degree in aeronautical engineering.

DR. ROBERT H. GRAY was named Space Shuttle Projects Office manager for NASA's Kennedy Space Center (KSC) in July 1973. He manages Space Shuttle operations planning, facilities preparations leading to launch, landing activities and refurbishment of the craft. Earlier, Dr. Gray was KSC deputy director of Launch Operations and director of Unmanned Launch Operations, directing more flights (178) than any engineer in the free world. He joined NASA in 1958 after three years as the Vanguard Launch Director and Deputy Manager of the Vanguard Group at Cape Canaveral for the Naval Research Laboratory. Gray was named chief of Goddard Space Flight Center Field Projects Branch in 1959, a post he held until going to KSC in 1965. Honors accorded Gray include the Navy's Outstanding Performance Award for the Vanguard program and from NASA the Distinguished Service Award and the Exceptional Service Medal. Gray graduated from Allegheny College, Pa., with a B.S. in physics and recieved an honorary Doctorate of Science from Allegheny in 1968. Dr. Gray was born in Cambridge Springs, Pa.

ROBERT E. LINDSTROM has been manager of the Shuttle Projects Office at NASA's Marshall Space Flight Center (MSFC) Huntsville, Ala., since March 1974, after serving as deputy manager for the preceding two years. From 1970-72, he was deputy director of MSFC's Process Engineering Laboratory. Prior to 1960, he was with the Army Ballistic Missile Agency as a Saturn project engineer and as project engineer for the Jupiter C vehicle which launched Explorer I. He joined MSFC in 1960 as manager of the Saturn I/IB program. Lindstrom left government employment in 1963, to serve in top posts in industry but rejoined Marshall in 1970. He holds numerous awards, including NASA's Exceptional Service Medal and the Director's Commendation Certificate. He was born in Sycamore, Ill., and received a B.S. degree in ceramic engineering from the University of Illinois.

GEORGE B. HARDY is manager of the Solid Rocket Booster project, Space Shuttle program, for MSFC. Earlier he served as manager of the Program Engineering and Integration project, Skylab program; assistant manager of the S-lB Launch Vehicle project; and deputy project manager for S-l/lB Stage Project in the Saturn program. Hardy began his professional career in 1952 with E. I. Dupont in Georgia; he moved to the Redstone Arsenal in 1958 and transferred to MSFC in 1962 as a project engineer. He is a native of Russellville, Ky., and graduated from Georgia Institute of Technology in 1952 with a B.C.E. in civil engineering.

JAMES B. ODOM is manager of the External Tank project, Space Shuttle program, at NASA's MSFC. Odom began his professional career in 1955, with Chemstrand Corporation, Decatur, Ala. He moved in 1956, to the Army Ballistic Missile Agency and in 1959, joined the organization that became MSFC in 1960. He has been associated with Earth satellite programs, lunar unmanned probes and the Apollo program. A native of Georgiana, Ala., Odom was graduated from Auburn University with a B.S. in mechanical engineering in 1955.

JAMES R. (BOB) THOMPSON, JR. is manager of the Space Shuttle Main Engine Project at NASA's MSFC. He served earlier as chief of MSFC's Man/Systems Integration Branch, Astronautics Laboratory. Thompson joined the propulsion research development team at MSFC in 1963, where he was responsible for component design and performance analysis of the engine system on Saturn launch vehicles. He is from Greenville, S.C.; and is a graduate of the Georgia Institute of Technology (1958) and the University of Florida (1963), with a B.S. in aeronautical engineering and an M.S. in mechanical engineering He is seeking a Ph.D. in fluid mechanics at the Univers of Alabama.

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ISAAC THOMAS GILLAM IV is Director of Shuttle Operations at Dryden Flight Research Center and is responsible for the Dryden activities in support of the ALT of the Orbiter. Prior to this, he was Delta Program Manager and Program Manager of Small Launch Vehicles in NASA Headquarters. Before his NASA assignment, Gillam served in the U.S. Air Force from 1953 to 1963 as a pilot, missile launch crew commander and ROTC instructor. After graduating from Howard University, Washington, D.C., Gillam attended Tennessee State University while working on graduate studies and serving as Assistant Professor of Air Science. Among other awards, Gillam has received the NASA Distinguished Service Medal for the Launch Vehicle Program. Gillam is a native of Little Rock, Ark.

DONALD R. PUDDY is flight director of Approach and Landing Test, Flight Control Division for the Space Shuttle Program at the Johnson Space Center. Past experience includes flight director for the Apollo Soyuz Test Project, and all the Skylab missions.

In Apollo he was Lunar Module environmental and electrical engineer (EECOM) for Apollos 5, 9 and 10, and during the powered descent and ascent of the LM on Apollo 11. He served as LM spacecraft analysis flight controller during Apollos 12, 13, 14 and 15. He was flight director on Apollo 16 and served as command and service module (CSM) spacecraft analysis flight controller for Apollo 17. Before assuming his present position he was chief of the Mission Operations Branch.

Puddy joined NASA in 1964 after four years in the U.S. Air Force working in high altitude research. He was born in Ponca City, Okla. He has a B.S. degree in mechanical engineering from the University of Oklahoma (1960), and is working toward a Master of Business Administration degree at the University of Houston, Clear Lake, Tex.

JOHN A. MANKE is the Chief of Flight Operations at the Dryden Flight Research Center. Prior to becoming Chief of Flight Operations, Manke was a civilian research pilot and assigned to the wingless lifting body flight research program that was demonstrating man's ability to maneuver and safely land a vehicle with a shape that was designed for space flight. As such, he flew the M-2, HL-10 and X-24 lifting bodies and made the first supersonic flight in a lifting body. Born in Selby, S.D., on Nov. 13, 1931, Manke attended the University of South Dakota before joining the U.S. Navy in 1951. He was selected for the NROTC program and graduated from Marquette University, Wisc., in 1956 with a bachelor's degree in electrical engineering. Following graduation, Manke entered flight training and served as a fighter pilot with the U.S. Marine Corps. Leaving the service in 1960, and prior to joining NASA, he worked for Honeywell Corp. as a test engineer.

SPACE SHUTTLE ORBITER - OV 101

CHRONOLOGICAL EVENTS

Aug. 9, 1972	NASA gives authority to proceed on Space Shuttle Orbiter contract. (Selection of Rockwell International's Space Division announced July 16, 1972.)
June 4, 1974	Orbiter Vehicle (OV 101) - Start structural assembly of crew module (Downey)
Aug. 26, 1974	OV-101-Start structural assembly of aft fuselage (Downey)
Mar. 27, 1975	OV-101-Mid fuselage (General Dynamics, San Diego) delivered to Palmdale facility
May 23, 1975	OV-101-Wings (Grumman, N.Y.) delivered to Palmdale facility
May 25, 1975	OV-101-Vertical stabilizer (Fairchild, N.Y.) delivered to Palmdale facility.
Aug. 25, 1975	OV-101-Start final assembly and mating (Palmdale)
Sept. 9, 1975	OV-101-Aft fuselage (Space Division) delivered to Palmdale
Oct. 31, 1975	OV-101-Lower forward fuselage (Space Division) delivered to Palmdale
Nov. 17, 1975	OV-102-Start fabrication of crew module (First orbital flight vehicle)
Dec. 1, 1975	OV-101-Upper forward fuselage (Space Division) delivered to Palmdale
Jan. 16, 1976	OV-101-Crew module (Space Division) delivered to Palmdale
Mar. 3, 1976	OV-101-Cargo bay doors (Tulsa Division) delivered to Palmdale
Mar. 12, 1976	OV-101-Complete final assembly and close-out systems installation (Palmdale)

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Mar. 15, 1976	OV-101-Start functional checkout (Palmdale)
April 19, 1976	OV-102-Start assembly of forward fuselage (Downey)
June 1976	OV-102-Start assembly of crew module (Downey) OV-101-Complete functional checkout (Palmdale) OV-101-Start ground vibration and proof load tests (Palmdale)
Aug.-Sept. 1976	OV-102-Start assembly of forward fuselage (Downey) NASA 747 (Boeing ferry aircraft) - Structural modification (Seattle)
Sept. 17, 1976	Rollout first Space Shuttle Orbiter (Enterprise) OV-101 (Palmdale) OV-102-Start assembly of aft fuselage (Downey)
Oct.-Nov. 1976	OV-101-Start retest (Palmdale) NASA 747 - Complete modification OV-101-Complete integrated systems check-out (Palmdale)
Jan.-Feb. 1977	OV-101- Configuration inspection (Palmdale Enterprise (101) - Delivered to DFRC OV-102-Deliver mid fuselage to Palmdale 747 Carrier Aircraft delivered to DFRC OV-101-First captive flight with NASA 747 (DFRC)
July-Aug. 1977	OV-101-First free-flight approach and landing test (ALT) (DFRC) OV-102-Start final assembly and closeout systems installation and aft fuselage to Palmdale OV-102-Deliver wings to Palmdale
Sept.-Oct. 1977	OV-102 Deliver crew module, vertical stabilizer, and body flaps to Palmdale
Nov. 1977	OV-102- Complete final assembly and close-out systems installation (Palmdale) OV-102-Start functional checkout (Palmdale
Jan. 1978	OV-101-Complete free-flight tests

Mar. 1978	OV-101-Deliver Orbiter to Marshall Space Flight Center, Ala. (MSFC) (ferried by NASA 747) for vertical ground vibration test
Apr. 1978	OV-101-Start vertical ground vibration (MSFC)
May 1978	OV-101-Deliver external tank for vertical ground vibration test to MSFC Ala.
July 1978	OV-102-Complete configuration inspection (Palmdale) OV-102-Final acceptance rollout (Palmdale)
Aug. 1978	OV-102-Deliver first orbital flight vehicle to Kennedy Space Center (KSC), Fla.
Dec. 1978	OV-101-Complete vertical ground vibration test (MSFC) OV-102-Ready for transfer to Pad 39A (KSC)
Feb. 1979	OV-101-Deliver to Rockwell, Palmdale, and start modification.
Mar. 1979	OV-102-First manned orbital flight, Space Transportation System (KSC)

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